INTRODUCTION TO EXPERIMENTAL EDUCATION

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PREFACE

THIS work seeks to make accessible in convenient form for English readers the main results of investigations in the new subject of Experimental Education. It is based on E. Meumann's "Vorlesungen zur Einführung in die experimentelle Pädagogik."[1] The material available since the publication of Meumann's work has been incorporated, and emphasis has throughout been laid on the results of English investigations. The publication of G. M. Whipple's "Manual of Mental and Physical Tests"[2] has enabled the writer to dispense with full descriptions and illustrations of apparatus. Appended to each chapter will be found a brief list of publications suitable for further reading: these references, which are in no sense exhaustive, are confined to English writings or works available in English, and indicate what may be regarded as most suitable and most readily accessible.

The thanks of the writer are due to Mr. J. R. Cameron, M.A., High School, Arbroath, for reading typoscript and proofs.

[1] Engelmann, Leipzig, 1st ed., 1907, 2 vols., pp. xviii + 555, 467.
[2] Warwick and York, Baltimore, 1910, pp. xiii + 534.

CONTENTS

EXPERIMENTAL EDUCATION

CHAPTER I

THE STANDPOINT OF EXPERIMENTAL EDUCATION

THE most important stage in the development of a subject of study arrives when its data and conclusions can be presented in quantitative as well as in merely qualitative terms; its claim to be recognised as a science can then no longer be disputed, for, as Herschel says, "numerical precision is the soul of science." The subject of Education is at length entering this definitely quantitative stage, and when the methods of investigation described as "Experimental Education" become generally applied, and the results universally accepted, Education will forthwith be recognised as an exact science.

That the traditional pedagogy cannot be termed scientific will generally be admitted; and the words in which Hume described the metaphysical sciences of his day might not inaptly be applied to the condition of current Education: "Even the rabble without doors may judge from the noise and clamour which they hear that all goes not well within. There

is nothing which is not the subject of debate, and in which men of learning are not of contrary opinions. The most trivial question escapes not our controversy and in the most momentous we are not able to give any certain decisions. Disputes are multiplied as if everything were uncertain; and these disputes are managed with the greatest warmth, as if everything were certain. Amidst all this bustle 'tis not reason which carries the prize, but eloquence; and no man needs ever despair of gaining proselytes to the most extravagant hypothesis, who has art enough to represent it in any favourable colours. The victory is not gained by the men-at-arms, but by the trumpeters, drummers and musicians of the army."

The older pedagogy, when it did not rely wholly on experience without attaining to principles, accepted principles without verifying them by appeal to experience. Many schemes of education have, for example, assumed the "recapitulation" principle without attempting to prove the parallelism, or to determine the points of correspondence, between racial and individual development. The classical school of educationists likewise adopted the doctrine of formal training, which implied that the power derived from pursuing a certain course of study could be applied indifferently in any sphere of mental life; but they omitted to determine to what extent a general improvement is secured by training a specific function, whether this general improvement is automatically transferred to other specific functions, or whether the improvement of the second

specific function could not be attained more economically by direct training.

The new pedagogy, however, claims to be scientific. It seeks to present its data in exact quantitative terms. It is inductive rather than deductive. Instead of following the old *à priori* methods, it adopts the sure method of experiment.

The claim that Education should be founded on experiment is not new. In the Appendix to "Practical Education"[1] by Maria and R. L. Edgeworth (1798) there is quoted Mrs. Honora Edgeworth's opinion that the art of education should be considered as an experimental science, and that many authors of great abilities had mistaken their road by following theory instead of practice. Pestalozzi[2] maintained that all branches of instruction demand analysis of their methods, and that the age at which each branch of instruction may be imparted to the child, should be exactly determined. Kant[3] also asserted that experimental schools must first be established before we can establish normal schools.

The recent advance in Education has only been made possible by the progress of such other sciences as anthropology, psychology, etc., which have helped to provide Experimental Education with its method. The way for this advance has also to some extent been paved by the results of the Child-Study movement, which, however, are themselves inadequate as a basis for the new method. Excellent studies of

[1] First Edition (1798), vol. ii. p. 734.
[2] "How Gertrude Teaches," English trans., p. 126.
[3] "Kant on Education," trans. by Annette Churton, p. 21.

individual children have been made by Preyer, Perez, Darwin, Miss Shinn, and Dr. Dearborn, but these stop before school age—just when they would have been of most value to the educator. The other department of Child Study is mainly statistical, yet its results cannot always be regarded as scientific. In most Child-Study investigations the questions employed are ambiguous, owing to inadequate analysis, and the statistics are frequently vitiated by the factor of "selection," for example, the answers recorded are given mainly by those to whom the questions happen to appeal. It is sometimes assumed that these objections do not hold when the range of replies is very extensive; but to this Dr. C. S. Myers says, "I want to protest as strongly as I can against the notion that any useful purpose can be served, so far as psychology is concerned, by collecting masses of psychological data with the help of an army of untrained observers. I have heard it confidently asserted that the gross errors inevitably arising from inaccuracies and inconsistencies of procedure among different observers cancel one another in the long run of such vast numbers of measurements. Nothing, I think, can be more dangerous or false than this idea that the untrustworthiness of crude methods diminishes as the number of observers increases. It involves the assumption that in the long run errors occur to an equal extent in opposite directions—a most unlikely hypothesis." [1]

[1] Myers, C. S., "The Pitfalls of Mental Tests"—a paper communicated to the British Association at the Sheffield Meeting, 1910.

The vagueness of the Child-Study methods can be illustrated by the variety of the views expressed on such a subject as the reasoning powers of children. One writer asserts, "Before a bright child can talk, he is already a reasoning human being, who will rapidly develop from his inner consciousness such a power of logic as passes understanding." [1] King, in "The Psychology of Child Development," states that some investigators conclude, from a study in children's inferences and reasonings, that there is at the end of the ninth year a marked increase in the logical faculty.[2] Mrs. Barnes, from her investigation on "The Historic Sense among Children," declares that the results of her test go to show that the number of inferences made rises decidedly at the age of twelve for boys and thirteen for girls; [3] whereas another writer on "The Reasoning Powers of Children" maintains that a considerable portion of those who have received a good education and have reached the age of fifteen, fail to show anything but the germs of thinking of a logical kind.[4] Such contradictory conclusions indicate that the methods employed are unscientific; the results are at best mere generalisations, suggesting hypotheses which require verification by more exact methods. Unfortunately, however, they are frequently set forth in statistical form, thus acquiring an absoluteness to which they have no claim.

[1] *Paidologist,* vol. v. p. 164.
[2] P. 187.
[3] *Studies in Education,* vol. i. pp. 47–53.
[4] *Paidologist,* vol. v. p. 159.

The new Education consequently turns to Child Psychology rather than to Child Study for its methods. Experimental Education is not, however, to be regarded merely as applied psychology. It is without doubt an independent science; for, although to some extent deriving its data from other sciences, it regards such data from its own special standpoint. In this respect it is best comparable with the science of geography, which, although dependent on astronomy, geology, etc., has nevertheless its own peculiar point of view. The distinguishing feature of Experimental Education is its practice of approaching all problems from the standpoint of the child of school age.

The subject includes the investigation of the physical and mental development of the child and the discovery and improvement of appropriate means of measuring such development. In addition to weighing and measuring the child, Experimental Education treats of sensory acuity and sensory discrimination, the types of observation, the various forms of memory, the nature of the child's mental imagery, and the part which such imagery plays in the child's thinking. It even attempts to estimate quantitatively a function so complex as general intelligence and one so subtle as suggestibility. The individual differences in children, disclosed by investigations in these directions, together with the extent to which intellectual and moral differences are dependent on the original nature of the child, and the limitations which such endowment sets to the work of education—all pro-

vide fruitful fields of inquiry. The most economical modes of learning, the fatigue involved in various forms of mental work, and the effect of school organisation on the child, form a special section; and the psychological analysis of the efforts of the child in the various school subjects—reading, writing, etc.,—is also a branch of Experimental Education of great practical importance.[1]

Valuable as are the results already obtained, the justification for Experimental Education does not solely depend on these; rather is it to be found in the questions being raised in spheres where formerly there was apparently nothing in dispute.

It may be asked how the new method will affect the position of the teacher. It will deliver him from the tyranny of tradition and the caprice of the faddist, and bring him under the servitude of his science, since the scientific worker must ever submit to the method of his subject. If it removes the domination of an arbitrary authority, it demands submission to a rational authority, one that can be questioned and tested.

Doubtless teachers will have but few opportunities of accomplishing original research work in Experimental Education. This requires a training which cannot form part of the ordinary professional course, and the time demanded by research work can hardly be given by one engaged in the routine duties of teacher. But, as Professor Dewey says,[2]

[1] *Cf.* Thorndike, *Journal of Educational Psychology*, vol. i. pp. 5–12.

[2] "Educational Essays," p. 158,

"unless our laboratory results are to give us artificialties, mere scientific curiosities, they must be subjected to interpretation by gradual reapproximation to conditions of life. . . . Now the school, for psychological purposes, stands in many respects midway between the extreme simplifications of the laboratory and the confused complexities of ordinary life. Its conditions are those of life at large; they are social and practical. But it approaches the laboratory in so far as the ends aimed at are reduced in number, are definite, and thus simplify the conditions; and their psychological phase is uppermost, while in ordinary life these are secondary and swallowed up." It is in the school, then, that the laboratory results must be put to the test. "The task of reviewing them is clearly one of great delicacy," and here the teachers will be able to render invaluable assistance to the new science.

Experimental Education, it may be added, does not profess to settle all the problems of education. It does not, for example, attempt to determine the general aim of education. Such determination falls within the sphere of social science or social philosophy.[1] Professor Ward has said in his article on Educational Values: "The first thing the educator should be clear about is what he intends, what his end and aim is, or rather should be. To ascertain this ideal, he must turn not to psychology, but to life: it is a social and ethical, rather than a psychological problem."[2] It is, however, for Experimental

[1] See Mackenzie's "Social Philosophy," 1st ed., pp. 352–59.

[2] *Journal of Education*, November, 1890.

Education to decide whether the aims are compatible with the child's nature and how these aims can best be attained. Experimental Education, then, although it does not comprehend the whole of Education, provides the empirical groundwork of the subject.

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CHAPTER II

THE METHODS OF EXPERIMENTAL EDUCATION

EXPERIMENTAL Education employs the methods common to all the exact sciences, namely, systematic observation and experiment: their advantages over mere casual observation and opinion do not require enumeration here.

Experimental Education consists largely of the application of the methods of Experimental Psychology to the school child, and the very existence of the subject, therefore, depends on the possibility of an Experimental Psychology. The validity of the latter has frequently been questioned, but the time has probably arrived when we can apply the pragmatic test, and, in justification of Experimental Psychology, maintain that the results are a proof of the possibility of the subject and of the correctness of its principles. It now remains to be considered how far the methods of Experimental Psychology are capable of application to school children. Frequently it has been maintained that children are incapable of introspection; but recent tests in child psychology show that the school child, at least from six years of age upwards, is able to introspect quite

satisfactorily in such simple experiments as the reproduction of presentations, and that, owing to the individual and concrete nature of his mental imagery, he can give more definite introspective detail than the adult. The high degree of suggestibility in children is also urged as an objection to the application of the methods of Experimental Psychology, but with proper care this can be overcome, or it can be estimated and allowed for. It is maintained, too, that the subject of an experiment should have some idea of the purpose of the test and that this is impossible with young children. Undoubtedly, by reason of the age of the subjects, certain limits are set to the application of experimental methods with very young children, but in such cases simple experiments only need be attempted; on the other hand, there may be certain advantages in the simplicity of the child's mental life and the *naïveté* of his outlook. Indeed, these factors sometimes make experiment easier with children than with adults, who are apt to introduce reflections and guesses as to the outcome of the test and thereby to modify their responses. An open mind, whatever it may be politically, can be of advantage psychologically.

No objection on methodological grounds is usually urged against the statistical methods employed by Experimental Education, provided the data are accurate.

The general methods can be divided into the two main classes, analytic and synthetic. The various educative processes may be analysed into their

several factors and each considered in isolation; thereafter the factors may be combined by synthetic experiment into the original complex process. For example, the reading process may be analysed into the visual apprehension of the words in continuous reading and the eye movements involved therein; the comprehension of the words whereby we attain the meaning of what is visually apprehended; and the vocal process whereby the meaning is expressed. These factors may then be investigated independently, and thereafter the task is laid upon synthetic experiment of explaining how these partial processes co-operate in producing the original process of continuous reading.

For educational practice, synthetic experiment is undoubtedly the more important of the two methods; but it presupposes adequate analytic experimentation, and it is a misfortune, inevitable at this early stage of the development of the new science, that the investigations should be mainly analytic and consequently not so productive in practical applications as might otherwise be expected. Consequently, many of the methods and results at first sight appear to have but little bearing on school practice; but they should not on that account be ignored. In the early stage of the development of experimental psychology it was protested that nothing of value could possibly come from the simple reaction experiments then practised; yet it was by the development of these methods that a highly complex process like thinking at length yielded to experimental treatment. The seemingly unproductive process of memorising of

nonsense syllables likewise provides us with clues and methods by which we may hope to solve some of the difficulties in the training of the child's will—difficulties which the teacher at present cannot hope to overcome, if he even recognises their existence. Practical results alone should not at this stage be demanded, since hasty conclusions and applications will only bring the subject into discredit.

Experiments may be "individual," when the tests are applied separately, or "mass" or "group" experiments conducted in class. Each type has advantages and disadvantages. Individual experiments enable us not only to investigate individual differences but also to obtain the subject's introspection, and thus to check the objective results of tests. The value of such control has been emphasised by Dr. Myers in the article previously referred to: "To neglect introspection," he says, "is usually to court certain disaster. If we are in total ignorance of what has been going on in the mind of the subject during the experiment, it is rarely possible to argue from the objective data—from the measurements which it yields. For example, we may be trying to determine whether any correlation exists between sensory discrimination and general intelligence. A positive result may be simply due to the fact that the very nature of the test has compelled the subject to use his intelligence while carrying out sensory discriminations. We may be correlating mental ability with mental fatigue, and neglect the fact that sometimes we may not be measuring fatigue at all, that in some subjects the task becomes

automatic, in others tedious, or that boredom may be in others overcome by motives of duty or ambition. We may be testing the visual acuity of two persons, and obtain a different result from each, despite the fact that really they have the same visual acuity. The result may be due to the fact that the one subject strains every effort to interpret what he but dimly sees, while the other only reads what he believes he can clearly see. Thus again we merely obtain a blurred or erroneous result from the blind applications of statistical methods to measurements which are really meaningless owing to our failure to analyse the conditions determining the character we are measuring."

Mass experiments, apart from the economy in time, may disclose uniformities which would otherwise escape notice. They should not, however, be undertaken without previous individual experiments to render the questions given in class quite unambiguous. Experimental Education has to determine what questions can be most appropriately investigated by the respective methods and how a proper balance between the two may be maintained.[1]

It is also important to know the number of cases necessary to be examined in order to obtain a result which may be regarded as typical. The danger of too few cases is obvious: we may get

[1] For determination of the relative value of the two methods in certain typical tests, see "Experimental Tests of Higher Mental Processes and their Relation to General Intelligence," by C. Burt (*Journal of Experimental Pedagogy*, vol. i. pp. 104–5).

contradictory answers to the same questions owing to the influence of individual differences. There is likewise danger with too many subjects, for by massing results obtained from subjects of different ages or nationalities or of varied social status—even within the same school—essential differences may be quite concealed.[1]

Galton states that from his experience with composite portraiture he believes it may attain statistical constancy within limits not easily distinguished by the eye, after some thirty haphazard portraits of the same class have been combined; [2] and he maintains that, generally, "numerical averages usually begin to agree pretty fairly when we deal with twenty or thirty cases." [3] It may also be remarked that as women exhibit fewer variations than men, a reliable average can probably be obtained with fewer subjects; [4] but if typical results are desired, experiments should not be confined to girls at the puberty stage, as they present great variations of development.

A method which has frequently been adopted by Winch,[5] and which is likely to be more extensively applied in educational experiments, is that known as the method of equivalent or parallel groups. When, for example, it is required to determine the effect of

[1] See Myers' article for illustrations of both forms of error.

[2] "Inquiries into Human Faculty," Everyman Edition, p. 12.

[3] *Ibid.*, p. 239. *Cf.* Brown, "The Essentials of Mental Measurement," p. 62.

[4] *Cf.* Thorndike, "Educational Psychology," 2nd edition, ch. iii.

[5] *E.g.*, *British Journal of Psychology*, ii, pp. 284–93.

training a particular mental function, the following procedure is adopted. A test is applied to a class before the period of training is entered upon, and, on the basis of the results of this test, the class is divided into two groups, each containing pupils of equal ability. One group is then trained in the exercise of the function in question, while the other is engaged upon different work. At the conclusion of the period of training, both groups are again subjected to a test. Should both show improvement over the original performance, and should the pupils of the trained group exhibit a greater improvement than their colleagues, we may ascribe the advance of the untrained group to natural development and endowment; and the difference between this and the degree of improvement of the practised group will give the measure of improvement due to training alone. When, however, a whole class is tested before training and again after training—without the control of an untrained group—it is impossible to estimate how much improvement is due to training and how much to natural development, or to determine whether the difference might not be accounted for by the final test being less difficult than the initial test.

The statistical methods common to Experimental Psychology and Experimental Education also call for brief mention. Results of tests expressed in numerical terms can be reduced in various ways, and for each series we must determine what is the most representative value by which it can be characterised.

There are three measures commonly employed to denote a series:—

1. The ordinary ***arithmetical mean*** or average is obtained by simply dividing the sum of the values by the number of cases, *e.g.*, the average height of a class is the sum of the individual heights divided by the number of pupils. This is the measure most commonly applied, but it is not always the most representative. In assessing the damages in a libel suit, for instance, the jury might agree on the average of the amounts suggested by the various members, say £60, £60, £75, £100, £125, £150, £150, £150, £200, £200, £250, and £1,000. The average in this case, £210, is clearly not representative, since ten of
15 the twelve jurymen would have awarded less. In such circumstances a crank carries weight in proportion to his eccentricity, whereas a just estimate should, as far as possible, discount the verdict of such a person.

An average is also valueless unless the range of variations is given. Two places might, for example, have the same mean annual temperature and yet entirely different climates, one presenting extremes of heat and cold while the other had an equable temperature. To indicate the variability of a series of values represented by the arithmetical mean it is necessary to state what is termed the ***mean variation***, symbolised by *m.v.* This is ascertained by finding the average of the differences between the arithmetical mean and the different values representing the series. Thus in the case quoted above the series runs 60, 60, 75, 100, 125, 150, 150, 150, 200, 200, 250, 1,000 and the arithmetical mean is 210.

The differences between the *a.m.* and the values

are: 150, 150, 135, 110, 85, 60, 60, 60, 10, 10, 40, 790 and the average of these differences, the mean variation, or *m.v.*, is $\frac{1,660}{12} = 138 \cdot 3$, which represents the range of variability of the series.

2. When it is evident that the extremes of a series are due to the presence of extraneous factors in the test, and it is considered desirable to eliminate these to obtain a representative value, the measure employed is that termed the *median*. To ascertain the median, the values are arranged in order of magnitude and the middle one selected as representative of the series; in the event of an even number of values in the series, the average of the two middle ones is regarded as the median. In the case already quoted the series runs: 60, 60, 75, 100, 125 150, 150, 150, 200, 200, 250, 1,000, and, as the series comprises twelve values, the median would be the average of the sixth and seventh, *i.e.*, 150. By the employment of this measure the representative value is not, like the arithmetical mean, affected by the extreme and abnormal value of 1,000.

To denote the range of variability in a series represented by the median, the semi-interquartile range is usually given; it is calculated by taking half the difference between the quartiles above and below the median, *i.e.*, half the difference between 100 and 200, or 50. Here again the extremes are eliminated.

3. The third measure used, the *mode*, is simply the value which occurs most frequently in the series. In the illustration we have been using, 150 occurs three times, and since no other value occurs more than

twice, 150 would be taken as the representative measure.

In experiments with numerous examples in the series the arithmetical mean may be employed and the mean variation, or some other measure of variability, also given. When the examples are not numerous and it is conjectured that disturbing factors may be influencing some of the results, the median should be employed, in which case the series should comprise an odd number of examples in order to simplify reduction. When the semi-interquartile range has to be calculated, 13 or 17 will be found more convenient than 11 or 15. The mode is used to characterise a type, that is, to indicate the case most frequently recurring.[1]

When a series of different tests has been applied to a number of subjects and each series reduced by any of the foregoing methods, for example, the arithmetical mean (*a.m.*) and mean variation (*m.v.*), it may be considered desirable to determine also the degree of difficulty of the various tests by comparing one series with another for all the subjects taken together. This may be accomplished by calculating the arithmetical mean and the mean variation of the representative values already computed; and to distinguish these measures from the ordinary *a.m.* and *m.v.* it has been suggested by Dr. Rivers that they should be symbolised by *A.M.* and *M.V.* respectively.[2]

[1] For further amplifications and qualifications of these measures reference is suggested to works treating specifically of statistical methods.

[2] *British Journal of Psychology*, vol. i. pp. 354–55.

Statistical methods have nowhere been more fruitfully applied than in the case of correlation; but the very ease with which the formula may be employed is apt to produce misleading results, owing to its application to data which have not been scientifically collected. Opinions on the natural affinities amongst the various mental functions and the various educational subjects have usually been vague and inconsistent, but the application of statistical methods now enables us to state in exact quantitative fashion the extent, if any, of such correlation. Several methods for ascertaining the degree of correlation are employed, but Spearman's *Foot-Rule* for measuring correlation [1] is likely to become the most popular in Experimental Education, since its ease of application more than counterbalances any lack of accuracy attaching to its use.

The following illustration given by Spearman [2] will indicate its simplicity:—

Subject.	Rank in First Test.	Rank in Second Test.	Gains in rank in Second Test.
A..............	7	6	1
B..............	4	4½	—
C..............	10	10	—
D..............	1	3	—
E..............	6	11	—
F..............	9	8	1
G..............	11	7	4
H..............	3	1	2
I..............	2	2	—
J..............	5	4½	½
K..............	1	9	—

Observed sum of gains (denoted by Σg)............ 8½

[1] *British Journal of Psychology*, vol. ii. p. 89.

[2] *Ibid.*, vol. ii. p. 95.

Spearman's method of calculating the correlation is as follows. Let the observed sum of gains be denoted by Σg: and the sum of gains to be expected on an average by mere chance be denoted by M; this amounts to $\frac{n^2 - 1}{6}$, where n is the number of cases in each series.[1] Then the correlational coefficient $R = 1 - \frac{\Sigma g}{M}$.

In the above example $n = 11$, so that—

$$M = \frac{121 - 1}{6} = 20.$$

Thus the correlation between Test 1 and Test 2—

$$R = 1 - \frac{\Sigma g}{M} = 1 - \frac{8 \cdot 5}{20} = 0 \cdot 57.$$

When there is a correspondence between the order of the subjects in the one test and the order in the other test we speak of a direct or positive correlation. When the correspondence is complete the degree of correlation is represented by + 1. If, however, it is found that the subjects who do well in one test do badly in the other, the correlation becomes inverse or negative; and if the opposition is perfect, that is, the subject best in one is worst in the other and *vice versa*, and the same relation obtains throughout the series, the degree of inverse correlation is represented by − 1. Should no relationship exist between the two series the degree of correlation is represented by 0. Between − 1 and + 1 any value may be

[1] For proof, see *British Journal of Psychology*, vol. ii. p. 105.

found. In this, as in almost all other probability formulæ, no scientific significance other than negative can be attached to an experimental result, unless it be at least twice as great as its probable error.[1]

It should be noted that, as Winch[2] has pointed out, "It seems to be possible to find highly correlated functions which appear to have very little relationship of pedagogical value. We cannot conclude, without further inquiry on other lines, that two highly correlated mental powers are causally related. If they have a common factor or a common cause, it may be one which our methods cannot influence, and its determination has then little value for practical direction, except in a negative sense. Two quantities may be highly correlated, but the ratios of their growth may not be, nor may we be able to produce increase in the one by producing increase in the other."

The question of the correlation of the subjects of the school curriculum has recently occupied much attention in pedagogical circles, and attempts have been made on somewhat *à priori* grounds, and with varying success, to relate each subject to every other subject. Experimental Education, before introducing methods of correlation, seeks to determine by the foregoing methods the natural affinities between the subjects to be correlated. The results obtained[3]

[1] For methods of computing probable error for the various formulæ given, see statistical works referred to at the end of this chapter.

[2] *Journal of Educational Psychology*, vol. i. p. 587.

[3] By Dr. E. O. Lewis.

by applying the coefficient of correlation to the class order of a Scottish school are surprising and perhaps worthy of mention. According to these calculations there is much less affinity between Mathematics and Manual Work than between Mathematics and English, and between Drawing and Writing there is very little connection. In the highest class of girls, English and French gave an inverse correlation, whereas English and Latin with the same girls showed a high degree of correlation. Too much importance should not at present be attached to these results, for they can be variously interpreted and may be due to the smallness of the numbers tested, or to the system of grading adopted by the teachers; but the manner in which the question is approached is characteristic of the new methods.

GENERAL METHOD.

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CHAPTER III

THE GENERAL DEVELOPMENT OF THE CHILD: PHYSICAL AND MENTAL

THE life of a child is probably best divided into the two periods—

1. Childhood—from birth to puberty, *i.e.*, to about 14 years of age, or 12 in the case of girls.[1]

2. Adolescence—from onset of puberty to maturity.

Childhood, according to Vierordt, can be further subdivided into (*a*) the age of infancy, (*b*) the early years of childhood until about 8, (*c*) boyhood and girlhood up to puberty; and adolescence into (*a*) early adolescence to 16 years with girls and 18 with boys, (*b*) young manhood and womanhood, to the close of the period of development, which we may put at about 20 for females and 25 for males.[2] These ages are only roughly approximate, and possibly in the future, for purposes of school classification and also for legal requirements, what is known as the "physiological"

[1] Fourteen is regarded as the legal age of a child in England under the Employment of Children Act, 1903.

[2] For relation of these divisions to school organisation see Findlay's "Principles of Class Teaching," pp. 95–102.

age, based upon pubescence, will be the determining factor.[1]

The development of the physical organs and mental powers of the child during these periods does not usually proceed regularly, but presents a certain rhythm or periodicity; there are stages of rapid growth alternating with periods of arrest and even of retrogression. It is obviously important that the teacher should be conscious of such variations, so as to turn them to account by providing exercise during the progressive periods and nursing or resting the pupil through intervals of arrest or retrogression.

Measurements of height indicate that from 6 to 9 years of age is a period of uniform and rapid development. At 9 the irregularities appear. There is at this age a retardation with girls, and with boys a more decided retardation occurs at 11 years of age. An acceleration of growth accompanies the pubertal change, attaining its maximum with girls at 13 and with boys at 15. Girls are shorter than boys except during the years 11 to 14, when they are taller; this is due to the earlier onset of puberty of girls giving them an accompanying advantage in growth during these years.

Similarly with weight, boys are heavier except during the years 12 to 15, when girls have the advantage. Again, at 9 in the case of girls and at 11 with boys there is an arrest in weight. The

[1] For physiological age see Alice Ravenhill, "Some Characteristics and Requirements of Childhood," p. 67; also, *Journal of Educational Psychology*, vol. i. p. 460.

greatest increase in weight with girls occurs at 13 or 14, and with boys about 16 years of age.

Measurements of vital capacity—or lung capacity—show that at all ages boys have greater vital capacity than girls. The increase with boys is greatest from 12 to 16 years of age, with girls from 11 to 14, the maximum increase being attained about 15 and 13 years of age respectively.

From these measurements it is evident that the most important variation in development occurs immediately before and during puberty. The onset of puberty varies according to race, and differs with the sexes, coming earlier with girls than with boys. On the average the periods most affected by pubertal change are 13 to 14 years with girls and 14 to 17 with boys. These changes influence all the physical and mental functions of the child, and it is, consequently, eminently desirable that their significance and effects should be known and regard paid to them.

Entrance to school usually causes an arrest or retardation in physical development, especially when the school conditions are unfavourable, and the effect is greatest on the weaker children.[1] Quirsfeld, at Rumburg (Bohemia), found[2] that with 21 per cent. of the pupils there was a decrease in weight during the first year of school life (six years of age), and with 25 per cent. there was no gain. At Halle, Schmid-Monnard

[1] Meumann, "Vorlesungen," 1st ed., vol. i. pp. 53–56; vol. ii. p. 128.

[2] Lay, "Experimentelle Pädagogik," p. 30.

found [1] that in the first three months of school attendance the weight of the girls of the elementary school decreased, and that the children of 7 years of age who attended school were lighter and smaller than those who did not attend school. The rate of mortality amongst children, it has been observed by several investigators,[2] also increases during the first school year. These results, it should be noted, have been got with children entering school at six or seven. What the physical consequences are in this country, where the compulsory age of attendance at school is five, we fear to contemplate.

The view held by most medical men, that the early period of school life is harmful, has been controverted by numerous educators. The child's natural freedom of movement, it is admitted, is undoubtedly restricted by his entrance to school, and the unaccustomed form of effort cannot affect his physical development favourably, since the child is easily fatigued and school does not provide adequate opportunities for recuperation. These objections, it is contended, can to some extent be overcome by improved school organisation. The compensating advantages claimed for attendance at school lie in the more regular mode of life, the habituation of the child to outward order, and in a certain self-control and self-reliance thereby acquired.

Winch has sought to determine what influence early entrance to school life has on school progress. His investigation was carried out in London, and

[1] Lay, pp. 45–46.
[2] Meumann, vol. ii. p. 128.

covered various types of schools. He concluded that, judged by intellectual results, and in so far as they are measured by school progress, no advantages can be claimed for early entrance to school ; that is, children who enter at three years of age progress neither more rapidly nor more decisively than those who enter at five.[1] This conclusion holds, whatever form of teaching is adopted, Kindergarten or formal. The early commencement of the formal subjects or the employment of Kindergarten methods does not guarantee any subsequent advantage over scholars who enter school at the legal age of five. There is likewise no advantage in early entry so far as the attainment of good behaviour and the development of attentiveness are concerned.[2]

It may be objected that the early entrants might come from poor homes, consequently suffer in mental and physical development, and thus make it easier for later entrants to overtake them. Winch's analysis, however, shows that this is not so. "Children from poor homes,"[3] he says, "not only do not exclusively form the early entering groups of Board School children, but they are fairly distributed over the various ages of entry and, even in the poorest neighbourhoods, a fair proportion of them come after five years of age."

Early entrance to school, it would appear, has no advantage educationally and is detrimental to the child physically. It should not then be made com-

[1] "When should a Child Begin School ?" p. 38.

[2] *Ibid.*, pp. 89–93.

[3] *Ibid.*, p. 86.

pulsory as it is at present in Britain. It may be urged that the homes of some of the children are not proper places for their education during this period. If that is the case, an institution intermediate between the home and the school may be necessary. The function of such an institution would be to attend primarily to the physical condition of the child and to the establishment of proper physical habits. We propose a separate institution for this age in order to remove the temptation to formal instruction and to admit of the conditions being freer than they are at school, and we suggest that these institutions should be in charge of nurses, rather than of teachers. The cost of such institutions might be met by the money spent at present, evidently to no purpose, on the teaching of, and the provision of school places for, children of the age referred to. The exact determination of the proper age for entrance to school is a social and economic, quite as much as a pedagogic, question.

The most powerful influence on the physical development of the child is, it appears, the social position of the parents. Some, indeed, have claimed that this is even greater than the effect of nationality. The higher the social status of the parents, the better is the bodily development of the children in so far as they are unaffected by other influences that are harmful.[1] This is strikingly confirmed by the physical measurements of Glasgow school children considered in relation to the number

[1] Meumann, vol. i. p. 51.

of rooms in the home. They may be tabulated thus:—

HEIGHT.

	Boys.	Girls.
One-roomed child ...	46·6 inches	46·3 inches
Two-roomed child ...	48·1 "	47·8 "
Three-roomed child ...	50·0 "	49·6 "
Four-roomed and over	51·3 "	51·6 "

WEIGHT.

	Boys.	Girls.
One-roomed child ...	52·6 lbs.	51·5 lbs.
Two-roomed child ...	56·1 "	54·8 "
Three-roomed child...	60·6 "	59·4 "
Four-roomed and over	64·3 "	65·5 "

According to the Report,[1] these figures show that the one-roomed child, whether boy or girl, is invariably, on the average, distinctly smaller and lighter than the two-roomed; the two-roomed than the three-roomed; and the three-roomed than the four-roomed. The numbers examined are so large and the results so uniform that only one conclusion is possible, namely, the poorest child suffers most in nutrition and growth. It cannot be an accident that boys from one-roomed homes should be 11·7 lbs. lighter and 4·7 inches shorter than boys from four-roomed homes. Neither is it an accident that girls from one-roomed homes are 14 lbs. lighter and 5·3 inches shorter than their sisters from four-roomed homes.

An investigation into the physical and mental

[1] Report on the Physical Condition of Children attending the Public Schools of the School Board of Glasgow, p. v.

development of Cambridge school children [1] in which 930 boys were examined—half from elementary and half from secondary schools—showed that whereas the stature and weight of the secondary school pupils are well above the "general" figures published by the British Anthropometric Committee, only 36 per cent. failing to reach the standards, 72 per cent. of the pupils attending elementary schools failed to reach the general standard.[2] Practically all the pupils of poor physique of both types were deficient in weight, from which we may infer that weight is a convenient index to the physical condition of pupils. The strength of the secondary school boys, as tested both with single-handed and double-handed pull, was also found to be greater than that of the elementary pupils at any given year of age.[3]

If it be the case, as some investigations seem to indicate, that children with a better physical development than the average do better school work—and Meumann even claims to have demonstrated that the memory development and general intelligence of

[1] Slefrig, S., "The Physical and Mental Development of Cambridge Children." Thesis presented for B.A. degree by Research, 1908, and deposited in Cambridge University Library. (Unpublished.)

[2] As the majority of these children must have been in satisfactory health, Slefrig suggests that elementary school pupils have a physical standard of their own, though a lower one than the general standard.

[3] This confirms the results got by Schuyten at Antwerp (Lay, "Experimentelle Pädagogik," p. 42), but contradicts MacDonald's conclusion, stated in Whipple, "Manual of Mental and Physical Tests," pp. 76, 77.

children from 9 to 14 years of age proceed parallel to the bodily development,[1] and, as indicated above, that the size of the home determines the physical condition of the child—the limitations set by social conditions to the work of education become strikingly obvious.

Exact measurements, physical and mental, also disclose periodic variations within the year.[2]

For increase of height there is a favourable period from February to August, an unfavourable from September to January; for weight an arrest during February to June and an increase from July to January. Muscular activity improves from October to January, diminishes from January to March, improves again from April to June, and diminishes again from July to September. During the year, the mental development proceeds in part parallel to, and in part inversely as, bodily development. October to January is favourable for memory and attention, January to March unfavourable; in summer muscular powers increase, while the powers of memory lessen. Generally, then, we may say that in summer the body is developed at the expense of the mind, or that man is then more fit for muscular than for mental effort.

[1] Meumann, "Vorlesungen," vol. i, pp. 52 and 59; also Lay, "Experimentelle Pädagogik," p. 33. Opinions on the correlation between the mental and the physical functions are somewhat at variance (probably owing to the difficulty in estimating general intelligence). See Whipple, "Manual of Mental and Physical Tests," ch. iv.

[2] Meumann, vol. i. pp. 59–62; *cf.* Claparède, "Psychology of the Child and Experimental Pedagogy," English trans., pp. 109–110.

The mental development of the child, like the physical, proceeds periodically or rhythmically and is likewise subject to certain variations which appear, to a large extent, to coincide with the physical variations. In the years of tardy growth the mental development is slow, but there are certain exceptions to this parallelism. The 11th year is especially unfavourable to mental development, and with girls the 12th, 13th, or 14th years—according to race and country—with a certain postponement of this unfavourable period till later in the case of boys. This, however, will be more fully demonstrated when we come to consider the development of the special mental functions of the child.

More important than the statement of the periods of mental development is the question, In what, strictly speaking, does the mental development of the child consist? Is it in the evolution of new powers, or in a distribution of mental functions different from that of the adult? Is the quality or character of certain processes typically different with the child, or does the difference lie merely in the fact that the child's capacity for work is quantitatively less than the adult's, the character of the work differing but little qualitatively?

If we consider the school child only, it may be said that the adult possesses no mental powers which the child of seven does not possess, although in the child these are present in a weaker and less perfect form.

These powers, on the other hand, are distributed differently. In the sense-perception of the child, for

example, the operation of apperceptive factors appears generally to preponderate largely over the given material of perception—that is, the perceptions of the child are much more subjective than those of the adult. This is evident from experiments on the testimony, and also on the reading, of the child. From such experiments we learn that the younger the child, the greater is the falsification of perception by reason of subjective conditions, and this falsification decreases uniformly with advancing years. In the ideation of the child, two main differences from that of the adult present themselves. The child thinks in concrete individual images; the adult employs mainly verbal images. The child can think in words just as the adult sometimes uses concrete images; but the distribution of the two forms of imagery is typically different in each case. On this follows a second difference; since the adult thinks chiefly in words he can attain more abstract thinking than the child, for words are essentially the forms in which our abstractions find embodiment. The child's thinking must be more concrete and particular than that of the adult; but the child of 6 to 14 years of age is capable of being trained in abstraction. The rate of the child's thinking is also slower, and this likewise may be due to a difference in the distribution of the types of imagery. A further consequence of the concrete nature of the child's mind is evident in volition. As the child thinks mainly in particular images, so he acts more on the impulse of the moment, whereas the adult acts on general resolutions or from rules of conduct.

The quality or character of the child's mental processes, especially the elementary processes, differs from the adult's until the child is well advanced in school life. The given factors constituting sense-perception and spatial and temporal apprehension are qualitatively different from such processes in the adult. The child, like adults of primitive races, discriminates fewer sense qualities, for example, colours, tones, etc., than the adult of civilised peoples. Possibly the sense organs of the child are not so finely differentiated. The same holds for space and time relations; the immediate apprehension of short intervals of time, as well as the comprehension of complicated time relations, is imperfect, and the latter only appears at a late stage and develops very slowly. In its apperceptive aspect the sense-perception of the child is typically different from that of the adult. The adult perceives things according to certain leading points of view or according to definite categories. The perception and observation of the child are determined by other categories than those employed by the adult, the dominant category varying with the age of the child. We shall see later that this is of great importance in observation lessons.

The striking difference between the perception of the child and that of the adult lies in the fact that the child, in proportion to his age, lacks the ability to synthesise particular impressions into a whole. This is evident in the case of any object of perception. In describing pictures, the six-year-old child as a rule pays no attention to the situation

represented; he names and describes only discrete particulars. Not only with complicated objects like those used in observation lessons but with the simplest relations this can be demonstrated. Children of six or seven years of age, for example, cannot compare distances between given points, because their attention is fixed on the single points and they do not synthesise them and what intervenes into spatial wholes; the difficulty of comparison is found to be increased by placing the points in various positions and requiring horizontal distances to be compared with vertical. The same inability to synthesise is evident in the child's apprehension of geometrical forms. It appears in drawing, more especially in the child's memory drawing. The synthesis of the represented particulars is very imperfect and the apprehension of the child clings to the particular objects, reproducing these without much regard to their relation to the whole. The objects drawn are consequently not reproduced in relative proportion; each stands by itself and its size varies according to the young artist's estimate of its importance. For instance, in sketching a house, a child will draw a large keyhole and indicate the remainder by a few strokes.

A defect similar to inadequate synthesis in sense perception is found in the child's volition. The child's impulses to action are at the outset isolated impulses of the moment, whereas the adult acts from systematised impulses.

If we consider the capacity of the child for all forms of mental and physical activity in their merely

quantitative or intensive aspect, we may state that the child is capable of less than the adult. This arises from the fact that the child is more liable to fatigue; and the younger the child the greater is the degree of fatigue. We may be inclined to doubt this, however, because of the many activities which appear to be easier for the child—mechanical learning, for example. But the adult's apparent difficulty is only due to his reluctance to exert himself. For, when willing to apply himself to mechanical learning, the adult can accomplish much more—usually five or six times and, under certain conditions, even ten times more—than a child of the age when, according to the traditional view, his power of mechanical learning is thought to be at its best. We may conclude, therefore, that in all forms of mental activity the child remains quantitatively behind the adult.

Having so far considered the general physical and mental development of the child, we shall next proceed to the consideration of the special mental powers.

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CHAPTER IV

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD

ATTENTION

THE importance of attention has always been recognised by educators, and even by psychologists it has frequently been regarded as the essential feature of intelligence. For some time it was believed to be the aspect of consciousness which gave the highest correlation with general intelligence, but tests involving the higher processes of reasoning have recently been demonstrated to give much higher correlations.[1] Although attention was considered by the older psychologists and educationists to be of great importance, it has been left to experimental methods to disclose interesting differences in the various forms of attention and to make us acquainted with the special characteristics of the child's attention.

It is still customary to speak of attention as if it were an indivisible or unanalysable power or faculty

[1] *Cf.* Burt, C., *Child-Study*, vol. iv. p. 93, and Freeman, F. N., "Über Aufmerkamseitsumfang und Zahlauffassung," *Pädagogisch-psychologische Arbeiten*, vol. i. p. 140.

which can be applied indifferently according to our wishes. But recent psychology has shown that attention, like memory or imagination, is but a name for a complex set of mental processes and not a simple function. Baldwin states:[1] "We have not one attention, but many. Attention is a function of the content, not a faculty which takes up the contents; and it is only as different contents attended to, overlap and repeat one another, that they have somewhat the same function of attention." Watt likewise says:[2] "According to our present knowledge there is no unitary cause which produces the effect known as the state or process of attention. It does not seem at all probable either, that when psychologists have done with finding out what factors influence attention for good or bad, there will be left any unitary process or anything at all which could be called attention. Attention is a popular name for a complex of states or processes of mind." The same conclusion is arrived at by Arnold[3] after a review of the experiments on the span of apprehension in the various sensory fields: "Attention in the visual field is something different from attention in the auditory field, and the same is true of attention in the tactile sphere. We cannot be said to possess any distinct and separate power of attention. In short, we have a number of attentions, and not a single power of attention."

Exercises have, nevertheless, been proposed for

[1] "Mental Development in the Child and the Race," p. 444.
[2] "The Economy and Training of Memory," pp. 37–38.
[3] "Attention and Interest," pp. 42–43.

the purpose of mind training, particularly of training in the concentration of attention, and amazing results have been claimed for them. But exact tests under laboratory conditions negative the conception of general ability in apprehension, or even of general ability in visual apprehension, and show that practice has but little effect upon the range of attention. What improvement there is, seems to be due almost entirely to habituation to the experimental conditions and to the adoption of devices in grouping material.[1]

The varieties of attention have been variously classified, and considerable discussion has taken place as to the most appropriate terms whereby to characterise certain of the aspects of attention.

The first division of the forms of attention, according to James,[2] is into sensorial, when attention is directed to objects of sense, and intellectual, when it is directed to ideal or represented objects. Sensitiveness to immediately exciting sensorial stimuli is said to characterise the attention of childhood and youth. Meumann maintains that, if we classify the forms of attention according to direction, we must recognise emotional and volitional attention, as our attention can be directed to volitional acts and to feelings.

Attention may be immediate or derived: immediate, when the object attended to interests us for its

[1] Whipple, G. M., "The Effect of Practice upon the Range of Visual Attention and of Visual Apprehension," *Journal of Educational Psychology*, vol. i. pp. 249–62.

[2] James, W., "Principles of Psychology," vol. i. p. 416.

own sake; derived, when it owes its interest to association with some other interesting object or process.

Attention may also be passive, non-voluntary or involuntary, or active and voluntary.[1] The term involuntary is ambiguous; and this ambiguity has given rise to much fruitless discussion as to whether the teacher should aim at training voluntary or involuntary attention. There is a primitive, instinctive, or reflex form of involuntary or non-voluntary attention which may be termed "enforced," and there is an apperceptive form which may be termed "spontaneous." It can only be this latter form to which Herbart refers when he says,[2] "It is involuntary attention that the art of teaching must seek to induce." In exciting the "enforced," non-voluntary form of attention in children, nothing is so effective as a brass band.[3]

Experiment has disclosed interesting individual differences in attention.[4] The liability to distraction varies with individuals, some being able to keep

[1] See Adamson, J. W., "Attention, 'entweder willkürlich oder unwillkürlich,'" *Journal of Experimental Pedagogy*, vol. i. pp. 4–6; also Drever, J., "The Kinds of Attention," *Journal of Experimental Pedagogy*, vol. i. pp. 151–57.

[2] "Outlines of Educational Doctrine," English trans., p. 62.

[3] Stout, in his "Groundwork of Psychology," p. 51, distinguishes between "enforced" and "spontaneous," non-voluntary attention and, after the manner of Herbart, states (p. 53) that the final aim of the teacher ought to be to convert voluntary into spontaneous, non-voluntary attention, by inducing direct instead of derivative interest in the subject matter.

[4] *Cf.* Münsterberg, H., "Psychology and the Teacher," p. 169.

attention concentrated in spite of serious disturbing influences, whereas with others attention is diverted by the slightest distraction. The power of adapting attention to new stimuli varies greatly, some individuals being able to adjust their attention easily and rapidly, others having only a slow adapting attention. Variations also occur in the length of time during which attention may be maintained. Experiment has also shown that some individuals have a typically roving or fluctuating attention, whereas others, belonging to the fixating type, have a narrower field of attention, within which, however, the presentations are clearer and more distinct.

The general effects of attention are well known. Presentations to which attention is directed acquire vividness and distinctness, whereas the other presentations which are in consciousness at the same time tend to become less definite. Whether the stimulus to which attention is directed, in addition to becoming more vivid, actually increases in intensity, is a problem which, although it has been the subject of several investigations, is still in dispute. The effect of attention is demonstrated by the results of the following experiment.[1] Thirty-six letters were read thrice with undivided attention, then repeated to the accompaniment of continuous movement of the finger, then accompanied by the singing of a note, and, lastly, the subject counted aloud while reading the letters. In the first case, of the 36 letters 21 were reproduced, in the second only 16, in the third 15, and the fourth only 11. The relation between

[1] Smith, W. G., *Mind*, 1895

concentration and distribution of attention has been stated reciprocally, that the greater the number of objects attended to, the less distinctly are they apprehended. It has also been suggested by Meumann that, on the basis of this relation, individuals could be classified into types; one type is characterised by great distribution and the individuals belonging to it are able to attend to many things at the same time; the other type avoids dealing with many things, but exercises great concentration on the few things attended to. Freeman,[1] however, maintains that the results of his investigation do not allow of the subjects being classified into two such types.

Another effect of attention is that it facilitates apprehension. Reaction-time tests demonstrate that when attention is directed to an expected stimulus the reaction-time is shortened.[2] Indeed, in some cases the stimulus is announced as apprehended before it is actually given. This shortening of the reaction-time is doubtless due to the adjustment of the sense organs for the reception of the expected stimulus.

The physiological accompaniments of the process of attention have been extensively investigated.[3] It is well known that when we desire to attend to a visual presentation we turn the head in the direction of the object, and that looking at the object involves the convergence and accommodation of the eyes.

[1] *Pädagogisch-psychologische Arbeiten*, vol. i. p. 135.

[2] James, W., "Principles of Psychology," vol. i. pp. 427–34.

[3] *Cf.* James, W., "Principles of Psychology, i., pp. 434–38; also Arnold, "Attention and Interest," ch. iv., v.

Even in intellectual, as distinguished from sensorial, attention there are movements of the body. If a person is told to think of something to his left, his body sways towards that side. Generally there is a tendency to movement in the direction of the object which for the moment is claiming the subject's attention. By suspending above the subject's head a blackened plate or sheet of glass, and attaching to his head a sharp-pointed instrument, such movements can be recorded.[1] Movements of the arm or hand can likewise be registered, and such movements are said to explain "muscle-reading" and "table-moving."[2]

The organic processes are also affected by attention. With close visual attention the breathing is uniformly decreased in amplitude. In rate it is sometimes increased, sometimes decreased, and sometimes not changed at all. With auditory attention it is nearly always decreased in rate, but changed irregularly in amplitude. These changes are probably adaptive; they remove a source of disturbance. Deep breathing, with its accompanying movements, would interfere with looking; rapid breathing interferes more with listening. In central attention, as opposed to sensory, the breathing is very little changed. With the effort of attention the strain tends to increase the rate of the pulse. Increased breathing, either in rate or amplitude, tends to increase the rate at which the heart beats. Re-

[1] For tracings, see Stratton, G. M., "Experimental Psychology and Culture," p. 204.

[2] *Ibid.*, p. 205.

stricted breathing, either in rate or amplitude, tends to decrease the rate of the heart. For the latter reason, a decreased rate of heart beat is often found with sensory attention, particularly at the first With central attention the heart rate is regularly increased.[1]

The physiological symptoms of the attention process may be arranged into three[2] or, according to Meumann, into four groups:—(1) the pure or primary accommodation processes of the higher senses, which are entirely reflex and beyond the control of the will and of all educative influences: (2) secondary accommodation processes in the posture of the head, trunk, hands, etc.; these in the adult appear as somewhat reflex—such as the alterations of the lens of the eye exhibited in the fixation of an object attended to—but are under the control of the will and subject to educative influences: (3) primary expression processes, like changes in the heart beat, in the rate of the pulse, in respiration, in tension of muscles, etc.; these are mainly organic and purely reflex: (4) secondary expression processes; these are in part aimless, a play of feature or gesture which, from the biological standpoint, may have once had significance in the evolution of the race. They disappear with age and training.

The symptoms which have positive educational

[1] Billings, M. L., and Shephard, J. F., "The Change of Heart Rate with Attention," *Psychological Review*, vol. xvii. p. 227.

[2] *Cf.* Arnold, "Attention and Interest," ch. iv., v.

value are those of the second class—the so-called secondary accommodation processes. They serve mainly to attune the body to the impression which is being attentively apprehended, to assist in its reception, and partly also to inhibit inappropriate movements. In this way our senses are brought into the most favourable condition for the reception of impressions; these become clearer, their maintenance in consciousness is facilitated, their feeling-tone and power of reproducing other ideas is increased, and consequently their associations with other presentations become more numerous and interest in them is deepened. All this favours the state of attention.

The educational importance of these processes must not, however, be overestimated. A pupil may, for example, be gazing intently at the blackboard while his wits are wool-gathering; but by causing him to adopt a proper attitude the tendency to digression may be combated and apprehension assisted.[1]

The characteristics of the child's attention, as distinguished from that of the adult, may be summarised as follows[2]: "The attention of the child is

[1] *Cf.* Stout, "Analytic Psychology," vol. i. p. 204; also Thring, "Theory and Practice of Education," p. 177: "Attitude makes false work, as well as betrays false work. A competent judge shall tell in a moment by simply looking through the window when the class is at work whether good work can be going on there. For though there can be true outward observance in some degree without inward truth, the converse is not possible. There cannot be inward reality without producing an outside corresponding to it."

[2] Münsterberg, H., "Psychology and the Teacher," p. 171.

always more liable to be distracted. It offers less resistance to any incoming disturbance. Moreover, the child's attention shifts more easily and fluctuates. As a matter of course, the child's attention is also by far more pre-disposed towards sense-impressions than towards thoughts and ideas. The adaptation of his attention is slow and fatigue sets in quickly."

According to Messmer, fixating attention is not to be found in the child, at least up to eleven or twelve years of age. Meumann has, however, by means of the tachistoscope[1] found a distinct fixating attention in children of six or seven years of age, but on the whole the fluctuating or roving type preponderated.

In regard to the physiological accompaniments of attention, it is evident that the child exhibits a greater display of motor processes than the adult. Every teacher knows with what energy the child in his work wrinkles his forehead, moves his lips, and rolls his tongue when writing. It is thus clearly seen that this play of motor processes is no index of the degree of attention, and that attention does not consist of

[1] The tachistoscope is an instrument for exposing to the subject of experiment a visual stimulus, a figure or word, momentarily or for a brief interval, say $\frac{1}{50}$ of a second. By its use the possibility of eye movements during the exposure is excluded. There are various forms of the instrument. Descriptions and illustrations of these will be found in *British Journal of Psychology*, vol. ii. pp. 244–46; Myers, "Text-Book of Experimental Psychology," pp. 412–17; Whipple, "Manual of Mental and Physical Tests," pp. 222–27.

these; otherwise the adult would have them to a greater extent, or attention would be lost with their inhibition. They are merely the expression of an undeveloped attention. Meumann found that in memory experiments only the beginner or unpractised subject accompanied his attention with movements or muscular tension; the more practised our attention is, the more do these accompanying movements disappear, so far as they are not essential to the perception itself. All excess of motor tension is harmful for mental work; it is a useless expenditure of nervous energy.

The foregoing indicates generally the differences between the attention of the child and that of the adult. The course of the development of attention is such that these differences are ever gradually disappearing, and the child by degrees acquires the typical qualities of the attention of the adult. The tests which have so far been applied to children seem to indicate that young children are not able to apprehend as many objects at a single glance as are older children, and when the time of exposure is shortened fewer are seen at once; and that with increasing age there is a wider range of attention at any given moment and a greater ability to hold attention for a longer time. Griffing, from experiments on the number of letters apprehended with an exposure of $\frac{1}{10}$ of a second, concludes that attention is a "function of individual growth, reaching its maximum only when the observer is fully developed."[1]

[1] Arnold, "Attention and Interest," pp. 53–54, 87, 95, and Whipple, "Manual," pp. 236–37.

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CHAPTER V

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

SENSE-PERCEPTION

AS sense-perception is ordinarily regarded as the foundation of all knowledge, the task is laid upon Experimental Education of determining what are the typical differences between the perception of the school child and that of the adult, and what development sense-perception undergoes during school life. For this purpose it is necessary to consider the material aspect of sense-perception (colour perception, auditory perception, etc.) and also the formal aspects of perception—the apprehension of spatial and temporal relations.

Colour Sense of Children.—In order to trace the development of the colour sense in his child, Preyer [1] employed what has come to be known as the "naming" method. This method may be applied in two forms. The colours—for example, green and red —may be presented, and the questions asked, "Where is red?" "Where is green?" Here the name is given and the colour required. Or the colours may be placed

[1] "Senses and Will," English trans., pp. 6–22.

before the child with the question, "Which is that?" that is, the name is required. Both methods were used by Preyer, with slightly different results; but as the latter was the more extensively applied its results alone need be considered here. According to the number of times they were correctly named, up to the thirty-fourth month, the colours arranged themselves in the following order, expressed in percentages of the number of presentations: Yellow, 96·7 per cent.; brown, 90·8 per cent.; red, 86·7 per cent.; violet, 85·3 per cent.; black, 84·8 per cent.; rose, 72·4 per cent.; orange, 67·1 per cent.; grey, 51·5 per cent.; green, 45 per cent.; blue, 28·8 per cent. Of the four principal colours, yellow and red were found to be named correctly much sooner than green and blue. Preyer, moreover, maintains that the incapacity of the two-year-old child to name blue and green correctly cannot be attributed solely to a possible inability to associate firmly the names "blue" and "green"; for the names yellow and red have already been employed correctly many months before.[1]

This naming method, as has been frequently pointed out, does not give an unambiguous index of the development of the colour sense in the child; it indicates, rather, how associations between certain colour names and the corresponding colours develop, and might be termed an "association" method. Baldwin[2] contends that this method involves no fewer than four different conditions: (1) the child's

[1] "Senses and Will," English trans., p. 21.

[2] "Mental Development in the Child and the Race," p. 37.

distinguishing of different colours simultaneously displayed before him, that is, the complete development of the child's colour-sensation apparatus; (2) the child's ability to recognise or identify a colour after having seen it once; (3) an association between the child's colour-seeing and word-hearing and speaking memories; (4) equally ready facility in the pronunciation of the various colour names which the child recognises. The method, however, may be employed when we desire to investigate to what extent the power of naming colours is developed; but to determine the development of colour sense itself, later investigators have attempted to eliminate altogether the factor of names.

Dr. C. S. Myers [1] has suggested a form of association method without names, which he has designated the method of "grasp and reward." Two coloured bricks, one red, the other blue, were presented to the child. Each time the infant picked up one of them, say red, she was rewarded with a sip of honey, syrup, or sugar. When she picked up the other (blue) brick, no reward was given. Thus it was hoped to build up in the infant's mind a definite association between red and reward, so that she would always tend to select the red brick when it was offered simultaneously with any other (coloured or colourless) brick. A similar method is employed in testing animals for colour blindness. Dr. Myers [2] holds that this method constitutes a test for colour confusion and thus differs from all other methods. In this

[1] *British Journal of Psychology*, vol. ii. pp. 353–54.
[2] *Ibid.*, p. 355.

respect it has the great advantage of being comparable with those commonly used for the detection of colour blindness in adults. Dr. Myers recommends this method—although he abandoned it and no results are therefore available.

Preyer, in addition to the naming method, employed that of matching colours. He took two counters of the same colour, and, giving one to the child, asked for one of the same colour to be chosen from a number variously coloured. Binet has also used this method and preferred it to naming. It was likewise employed by Miss Tucker at Cambridge with school children, the Holmgren wools being substituted for counters. The children were at the infant-school stage and their mistakes were the same as those made by primitive peoples. Blue is most often confused, generally with violets and later with greens; green naturally follows; then yellow; and with the younger children red too extends its range. Colour discrimination, as thus tested, shows increasing exactness with increasing age.[1]

Binet and Garbini applied the method of recognition, in which a colour is pointed out to the child, who is required to seek it amongst a number of others. Baldwin objects to this method on the ground that a child might possibly fail to recognise an isolated colour quality, when he could very well distinguish colour qualities side by side.

These methods, the matching and the recognition methods, attempt to eliminate the influence of word memories; but, as Baldwin states, this is not possible

[1] *British Journal of Psychology*, vol. iv. p. 35.

with children of five years of age or even younger. He refers to the conclusions of Lehmann, that coloured wools are recognised when the colours are those whose names are known, and that shades which have no peculiar names, or whose names are unknown, are not recognised. Miss Tucker in her Cambridge experiments found that the colour names are generally known—none of the children in her investigation were younger than five—and that where the name for blue is unknown, the colour is invariably confused with violet; this happens, nevertheless, even when the name is known. From the results of tests on children from three to five years of age, Winch also concludes that discrimination and naming of colours are independent.[1]

Baldwin introduced what he calls the "dynamogenic" method,[2] that is, the method of determining preference by the motor force which a given stimulus excites—for example, by the amount of reaching movement which the child makes to grasp a colour. This method is independent of the child's comprehension of language. A rod was placed horizontally before the child, parallel with the shoulders, and so equally distant from both hands that its distance from the child could be definitely regulated. On this rod the colours were placed successively, the object being to excite the child to reach for the colour. The number of tests was 217; of these 111 were with five colours and 106 with ordinary newspaper, chosen as a relatively neutral object. To determine

[1] *American Journal of Psychology*, July, 1910.

[2] "Mental Development," pp. 48–49.

the order of preference, the proportion of acceptances and rejections at the various distances was calculated, and the colours took the following order of attractiveness, viz., blue, red, white, green, brown. Yellow was, unfortunately, not included in the investigation.[1]

Dr. McDougall[2] has suggested a modification of Baldwin's method. The objects presented in pairs to his child were balls about one inch in diameter, each consisting of a pill-box, containing a pea, and embedded in a loose sheath of knitted wool. The woollen thread was prolonged at one point to form a plaited cord about three inches in length. The balls were made of red, green, blue, yellow, white, and grey wools. The colours were rich and the grey of a decidedly bright shade in order to ensure that any preference exhibited was not due to superior brightness. The two balls, about five inches apart and equally distant from the child's face, were dangled by their cords within easy reach. If he did not at once reach out and grasp one of the balls they were jerked slightly and the rattling usually arrested his attention and led to a grasping movement. If he did not take one or both balls within half a minute, they were removed and a fresh attempt made after a short interval. This method has certain advantages over Baldwin's method, in which only one colour was presented at a time, and which, according to McDougall, can neither show that colour vision was present nor throw any light on the state or

[1] For criticism of Baldwin's method and results see McDougall, *British Journal of Psychology*, vol. ii. pp. 350–51.

[2] *Ibid.* vol. ii. p. 338.

development of colour sense. McDougall maintains that his method is capable of affording evidence of the state of the colour sense from the sixth month onwards, and perhaps even during the fifth month. The experiments indicate that red, green, and blue are appreciated during the sixth month, since they are decidedly preferred to white and still more to grey of corresponding brightness; moreover, in the sixth month no one of these three colours is markedly preferred to the others, but there is a faint indication that during the fifth month blue is less appreciated than red.

Myers agrees with McDougall that at a very early age—probably long before the sixth month—infants are susceptible to relatively small differences of brightness; that at this age reds and yellows are distinctly preferred to other colours and to colourless objects of far greater brightness; and that novelty may be an important factor in determining the infant's choice of colour.

But Myers protests against conclusions as to the development of the colour sense being based on the colour preferences of infants. "I am convinced," he says, "that it is extremely dangerous to formulate any opinion on the actual colour experiences of an infant as the result of observing what coloured objects he prefers or rejects, when these objects are presented with other coloured or colourless objects." He illustrates the point thus: Supposing that an infant showed a preference for the taste of syrup and lemon juice, and supposing that he showed no preference when he had to choose between lemon

juice and beer, who would venture to conclude that the sweet taste was already developed in the infant but that the sour and bitter tastes were not yet differentiated from each other? Yet, he adds, conclusions on precisely these lines are drawn by those who have in a similar manner investigated the colour preferences of infants.[1]

The development of the colour sense in children must be approached directly and not through preferences in choice. English children examined quantitatively with the tintometer,[2] as by Miss Tucker at Cambridge, were found to differ in no way from European adults, although all the averages increase enormously the younger the children are. But, although in matching colours blue is regularly confused with green, it is found that, tested by the tintometer, the ratio of the blue threshold—that is, the intensity requisite that the colour may be just perceived—to that of red or yellow remains constant throughout, so that the confusion of blue with other colours by children is not due to a defect in the perception of this colour. With increasing age there is a gradual decrease in the thresholds of discrimination of the various colours, but their relation to one another remains absolutely regular throughout. Miss Tucker also states that the quantitative results were not influenced by pigmentation of eye—the thresholds for dark eyes being the same as those for light eyes —nor by the standard of intelligence of the pupils.

[1] *British Journal of Psychology*, vol. ii. p. 359.

[2] For description of instrument and procedure adopted, see Myers, "Introduction to Experimental Psychology," pp. 33–34.

Some investigators maintain that women and girls slightly excel men and boys in colour discrimination, but this also has been denied.[1]

This form of test also enables us to determine the extent of colour blindness. Miss Tucker found that with the Cambridge school children examined, colour blindness exists in the same proportion as amongst English adults, namely, 4 per cent., and this is confined to boys. To the subject of colour preferences we shall return when dealing with the æsthetic development of the child.

Sound Perception.—We know less of the development of the child's sense of sound than of his sense of colour. The child's perception of sound has been tested in connection with the investigation of the contents of children's minds on entering school, by determining the percentage of children who can sing a song by heart or repeat a tune sung; it has likewise been determined more exactly by psychological methods. The former method does not admit of definite conclusions, since its results are largely determined by accidental educative influences. Both methods disclose extraordinary individual differences; musically gifted children often learn to sing before they can speak (even as early as the end of the first year), whereas the child entering school is usually incapable of recognising differences in tone or tone intervals or of remembering simple harmonies.

Statistics of Annaberger[2] schools demonstrate

[1] *Cf.* Whipple, "Manual of Mental and Physical Tests," p. 164.

[2] Stanley Hall, "Aspects of Child Life and Education," p. 45.

that only 20 per cent. of new scholars can sing a song from memory, and that about 36 per cent. can sing a song or part of a song after it has been sung to them. This is important, for it shows that in music instruction we should not expect too much from children who have just entered school.

The psychological tests may be divided into two classes—those which seek to determine auditory acuity or the absolute limits of hearing, and those which investigate discrimination in pitch. As it is important to know which children in a class are colour blind, so it is even more important to know those with defective hearing. Various methods have been employed to test the auditory acuity of children,[1] and as the conditions under which the tests were applied were not identical, the results are not quite in agreement. In a Chicago investigation with 6,729 children, 1,080, or 16 per cent., were defective in one or both ears, 6·64 per cent in both, and 9·55 in one ear. The results of other investigations give as hard of hearing or with defective hearing, New York, 13 per cent.; Riga, 22·2 per cent.; Stuttgart, 10 to 30 per cent.; Bordeaux, 17 per cent.; Paris, 22 to 25 per cent.; Munich, 25·8 per cent. Differences appear between the two ears, but Whipple[2] remarks that for practical purposes the determination of this difference is only significant when the inferiority of one ear is marked; in such cases pupils should be so seated in the class-room

[1] For methods see Whipple, "Manual of Mental and Physical Tests," pp. 166–80.

[2] "Manual," p. 177.

as to turn the "good" ear towards the teacher. As with colour acuity, there is an improvement in auditory acuity with age. Investigators are almost unanimous in maintaining that defective hearing has a positively injurious effect upon school-standing.

Gilbert[1] sought to determine the child's capacity for pitch discrimination, to discover whether at the various ages there were any, and, if so, how many pupils who could not distinguish to a half-tone. The bearing of the investigation on music instruction is obvious.

Five boys and five girls of each age except eighteen and nineteen were tested; for these ages girls only were tested. As the object of the investigation was to compare children with one another, a single fundamental tone was used throughout, namely, the tone $\bar{a}=435$ of international pitch. The method was that of minimum gradation, ā being first sounded, then a note $\frac{1}{32}$ of a tone higher, and the child was required to answer "same" or "different": ā was again sounded, then a tone $\frac{2}{32}$ higher, and so on, the second tone being raised $\frac{1}{32}$ each time, until the child had several times declared the tones to be different. Thereupon the second tone was started at the same pitch as the first and in like manner successively lowered. The number of thirty-seconds of difference that were just perceived gave the result for a single test.

[1] Gilbert, J. A., "Experiments on the Musical Sensitiveness of School Children," *Studies from the Yale Psychological Laboratory*, vol. i. (1892–3), pp. 80–87.

The complete results were:—

Age	6	7	8	9	10	11	12
Least perceptible difference in 32nds of a tone.	12·3	9·1	6·8	4·8	6·2	4·8	4·1

Age	13	14	15	16	18	19
Least perceptible difference in 32nds of a tone.	3·7	3·5	5	4	2·6	2·4

Gilbert concludes that the pupils are fully capable of the task required of them in music instruction. The least sensitiveness occurs with children of six years old, with whom the average just perceptible difference is 12 thirty-seconds, or $\frac{3}{8}$ of a tone. Of the children examined there were only three whose averages exceeded half a tone. It is evident from the above results that the least perceptible difference decreases with increasing age, that is, sensitiveness increases. This increase is at first rapid but later almost stationary. At the ages ten and fifteen, however, exceptions occur, and to verify the data for those ages Gilbert repeated the tests with increased numbers of pupils but without having to alter his results. The loss of sensitiveness at these ages Gilbert attributes in the one case possibly to the second teething, which occurs at nine to twelve years of age and which may have such an influence on mental life as to cause a loss of sensitiveness, and in the other, more definitely, to puberty, the average onset of which may be put at fourteen years and five months. It will be noticed that these sudden changes divide the development in pitch discrimina-

tion into three uniform stages—from 6 to 9, from 10 to 14, and from 15 to 19 years of age.

Practice likewise affects the power of discrimination, but the degree of such improvement and the limits set to it are still in doubt. The correlation between pitch discrimination and general musical ability is also in dispute. Sex differences and correlations between pitch discriminations and intelligence have been both affirmed and denied, but we may expect the application of more extended and more exact tests to settle these questions definitely.[1]

The other sense spheres, for example, the tactual, olfactory, gustatory, etc., have not been so adequately investigated as the visual and auditory; but the results would not be of equal educational value.

Perception of Space.—The space sense of the child is much earlier developed than the colour sense; in fact, it is already well developed when the child enters school. Preparatory to his tests on mental association Ziehen investigated the mental contents of the children attending Professor Rein's Seminar School at Jena, and in doing so found that a mètre was correctly indicated by most of the children. Ziehen, indeed, was surprised at the accuracy of the space ideas of the pupils, who ranged in age from eight to fourteen years; with only two

[1] Myers, "Introduction to Experimental Psychology" (p. 93), concludes, from a comparison of the threshold for differences of pitch of primitive peoples and civilised communities and from the fact that the threshold was less with pupils of "Preparatory" schools than with those of Elementary schools, that intelligence, education, and general culture are important factors.

of the forty-five tested was the spatial sense almost totally undeveloped.[1] It is easy to understand that education has a considerable influence on this development, more especially the education of ordinary life; the sense of distance is developed by the force of circumstances which requires the child to find his way about his environment. At the outset the idea of distance of objects arises through the movement of grasping; the child learns first those distances which are connected with his grasping movements. A wider and better understanding of distances is further developed when the child can measure distances by traversing them. Only those distances which we have actually traversed are properly understood by us; of others which we have not experienced we can hardly have an adequate idea.[2]

The judgment of distance by the eye is with the child fairly exact for short distances; in the case of children of six or seven years of age this is not much behind that of the adult, and it is thus evident that it is very early developed.[3] Meumann also states that the visual illusions are very early recognised by children—even by children as young as six. With regard to the over-estimation of the length of vertical lines relatively to horizontal—an illusion which it is important to recognise in drawing instruction—it seems that it is less with adults than with boys in junior classes, and Winch has demonstrated that it decreases with increasing age and school progress.[4]

[1] Ziehen, "Die Ideenassoziation des Kindes," p. 8.
[2] Meumann, vol. i. pp. 111–12. [3] *Ibid.*, vol. i. p. 113.
[4] *British Journal of Psychology*, vol. ii. pp. 220–25.

is, at 8 years of age. In this class not a single right answer was given, and at the end of the school-year Ziehen determined that nine boys, including three of the intermediate class, had still no approximate idea of the number of days in the year. The answers of these pupils varied between 20 and 160 days. By questioning children of five and six years of age Meumann has become convinced that all complex conceptions of time are completely unintelligible to them. When we say to a child that an incident happened yesterday, the day before yesterday, weeks ago, or years ago, this is for him only an obscure reference to the past: so with references to the future. A child of six has likewise no idea of the seasons—at least as periods of time; all he knows is the fact that it is cold in winter and warm in summer.

The exact determination of the child's sense of time for the various ages is important pedagogically, as time relations are continually referred to in teaching, especially in the teaching of history; and it would be well for the teacher to know to what extent he could rely on an understanding of these. A boy aged five, whose life history the writer knew intimately, could not be got to date anything beyond 3 weeks; at 7½ years of age he would go as far as 6 months but not beyond it. Another boy of 8 years of age would likewise not go beyond 6 months. Everything before that seemed to be simply in the past. The perception of time intervals appears to be in this respect somewhat analogous to the perception of space. For near distances our space

perception is tridimensional and we can perceive depth. Beyond a certain distance, everything appears in the same plane, for example, all the stars seem equally distant. If we may regard time similarly, we may say that we can distinguish the relative position of near events, but distant events appear all in the same plane, this plane receding with increasing experience.[1]

[1] *Cf.* "There is a law, Prof. Paul Janet says, by which the apparent length of an interval at a given epoch of a man's life is proportional to the total length of the life itself. A child of ten feels a year as $\frac{1}{10}$ of his whole life, a man of fifty as $\frac{1}{50}$, the whole life meanwhile apparently preserving a constant length" (James, "Principles of Psychology," vol. i. p. 625).

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CHAPTER VI

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (*Continued*)

APPERCEPTION.

According to Prof. Stout,[1] "the main principle which psychology lends to the theory of education, as its starting-point, is the need that all communication of new knowledge should be a development of previous knowledge." Although this principle—the doctrine of apperception—is as old as Socrates, it has been left to Experimental Education to determine the forms according to which apperception operates for various ages, and also to institute investigations as to the actual content of children's minds.

The experimental investigation of apperception has two aspects, which we may term respectively the "formal" and the "material." The first seeks to determine the forms or categories according to which the child, at various stages of development, observes and describes objects presented to him, and which consequently distinguish the operation

[1] "Analytic Psychology," vol. ii. pp. 137–38.

of the child's apperceptive process from that of the adult; the other seeks to determine the existing mental content with the aid of which the child at various ages interprets the given material of perception.

Definite categories of observation appear to be typical of certain ages, and the exact determination of these is obtained by testing the observation and testimony of children.[1] To determine the accuracy and development of the child's testimony, pictures or simple objects are exhibited for a short time, say ten seconds, and immediately withdrawn. The pupil is instructed to observe the pictures or objects while they are exposed, and then he is required to describe what he remembers of the objects seen. His first spontaneous account is termed technically the "Report";[2] thereafter he is questioned by the experimenter, and this process is termed the "Cross-examination." After a given interval—an hour, a day, a week, etc.—the report and cross-examination may be repeated. From such investigations it is obvious that children, according to age and stage of mental development, view things according to quite different categories or points of view. Stern has distinguished three or four stages in the development of the child's apperceptive process. The first he calls the *Substance* stage; this term signifies that at the outset children observe only single disconnected objects or persons. The Substance stage is

[1] For tests, see Whipple, "Manual," ch. viii.

[2] For "Bericht"—"Verhör," Whipple uses "Narrative" and "Interrogatory."

followed, about the eighth year, by the *Action* stage, when human actions and activities are observed. Thereupon follows the so-called *Relation* stage, which begins in the eighth or ninth year, and in which the spatial, temporal, and causal relations of things are observed. Lastly comes the *Quality* stage, in which children analyse things into their qualities.[1] The test is so simply applied that it is unnecessary to illustrate the results here. In fact, it may be applied inversely; in supervising the teaching of students, the writer has set them to determine the ages of the pupils in the class from the nature of the replies given in a lesson on a certain picture.

The fact that the use of certain categories is lacking in pupils at certain ages, is obviously of great importance for some branches of instruction. Meumann consequently commissioned Frau Dr. Dürr-Borst to determine how far this defect could be remedied by training. She instructed the pupils to observe according to certain definite categories, for example, colour, space-relationship, size of objects, etc. After this preparatory instruction, the picture test was again applied, and a general improvement in systematic observation resulted,[2] brought about by the observance of a definite order in observation; by instruction in the material aspects, for example, in the recognition and naming of colours, forms, etc.; but mainly by

[1] *Cf.* Whipple, "Manual," pp. 306–307; and *Journal of Educational Psychology*, vol. ii. p. 256.

[2] "Vorlesungen," vol. i. pp. 118–19. *Cf.* Whipple, "Manual," p. 310; also *Journal of Educational Psychology*, vol. ii. pp. 259–260.

greater conscientiousness on the part of the pupil. Meumann is nevertheless convinced that this improvement is only temporary, and that if children are trained to employ higher categories than those appropriate to their stage of development, they use them only with difficulty and drop them when the training ceases. If, then, at the infant stage of school life we prescribe observation lessons dealing mainly with the qualities of objects, our teaching is vain; immediately the training ceases, the child relapses into the use of the category appropriate to his age. We might also infer that it is more important that the pictures used in teaching should correspond to the stage of the child's apperceptive development than that they should be artistically coloured.

Stern has demonstrated that the use of the categories according to which children consciously or unconsciously observe does not develop gradually, but that at a certain stage a category not previously employed appears quite suddenly, is forthwith spontaneously applied, and then shows no further development. All these categories appear earlier in boys than in girls; but in the upper classes the sexes become level in this respect. Certain categories preponderate with girls, others with boys, for example, the personal with girls and the objective with boys.

The progress due to age in the development of observation is very considerable throughout life. Whereas with seven-year-old children every third element of positive statement is false, with fourteen-year-old children only every fifth statement is false. Most errors arise with numbers (in answer to the

question, How many?), then come statements on colour, then actions of persons, then descriptions of objects. Space relations and statements on uncoloured properties of things are given almost correctly.[1] This progress with age, like the child's general development, shows periods of advance, of arrest, and of retrogression. With boys the period from 7 to 10 years of age is a time of rapid development, and after that the development is slower. With girls at 10 there is a certain arrest and from 10 to 14 rapid development.

With reference to accuracy of testimony, Stern maintains that boys return a greater number of correct statements than girls; in positively false statements the sexes are about alike, but girls give the more indefinite replies. The superiority of boys becomes more evident when the more difficult forms of testimony are considered—statements on colour, for instance.[2] The ratio of the degree of spontaneous report to cross-examination varies with the sexes according to age. Girls of the intermediate classes—that is, about eleven years of age—are inferior in spontaneous observation to boys, but in the junior and senior classes they excel the boys; although girls are superior in the amount of spontaneous observation, they are inferior in regard to the fidelity of their reproductions. It further appears that the spontaneous observation of all pupils turns more to personal relations than to lifeless things, more to objects than

[1] See Whipple, "Manual," p. 308.

[2] *Cf. Ibid.*, pp. 305–306, where the evidence appears conflicting.

to qualities and relations, more to spatial relations than to colours. What decides the choice in observation is not what strikes the senses, not the intensity or liveliness of external stimuli, but the circle of interest of the child.

The accuracy of the testimony of individuals possessing a fixating type of attention is greater than with subjects endowed with fluctuating attention; and the testimony and the observation of persons of a mixed imagery type are superior to those of a pure type.

It may be added that the younger the children the more subjectively is their observation determined; and girls are more subjective in this respect than boys. The observation of children becomes more objective as the interest diminishes; concerning objects in which they are interested, a greater number of statements are made, but they are less trustworthy.

We have thus far dealt with the formal side of the apperceptive process; it is, however, important educationally to know the actual mental content of the pupil at the different periods of development. This has to some extent been accomplished for children entering school, but it is also essential to determine the mental content at the various stages of school life. For the vague opinions on the mental content of their pupils with which teachers are usually satisfied there must be substituted a knowledge which is capable of being expressed in exact quantitative terms. Inventories also require to be undertaken in different districts with pupils of differing social status, for in

no field of Experimental Education is there greater danger of assuming that the same results hold under different conditions. This, too, is not a psychological, but, as Münsterberg has pointed out, a sociological and pedagogical problem.[1]

The systematic determination of the pupil's mental content would be valuable in many respects; it would disclose the knowledge and the ignorance of the pupil. The teacher would also learn the direction of the child's interest, the exactness of his perceptions and memory images, the certainty of his recognition of previously experienced objects and processes, the extent of his vocabulary,[2] his capacity for correctly naming objects, and the categories and concepts under which he arranges his perceived material. The teacher would thereby come to know the material upon which he has to work, what he may and may not assume, where the typical defects in the child's experiences lie, and with what apperceptive material his instruction may be connected.

[1] "Psychology and the Teacher," p. 230.

[2] In the Report of the Committee of Council on Education in Scotland, 1905–6, p. 287, Mr. J. C. Smith, now Chief Inspector of Training Colleges in Scotland, gives the results of an investigation carried out in three typical schools in Glasgow with the view of ascertaining the actual vocabulary of an average child at five years of age. This brought out the fact that the *English* vocabulary of a slum child of five did not extend beyond some two or three dozen words; on the other hand, it was found that an average child of five from a good middle-class home had command of, or understood, not less than a thousand English words, while bright children carried the number up to one thousand five hundred or even to two thousand.

The results of the investigations in this direction are now easily accessible in Stanley Hall's essay on "The Contents of Children's Minds on entering School,"[1] which is probably the most valuable contribution of the Child-Study movement to the new Education. It may suffice to cite the following from one of the American investigations: 54 per cent. of the children entering school did not know a sheep; 61 per cent. had not seen potatoes growing; 35 per cent. did not know what clouds were; 48 per cent. were ignorant of what a river was; 35 per cent. of a circle; 62 per cent. did not recognise a spade; 50 per cent. could not tell the origin of butter.[2]

Stanley Hall concludes[3] that from such results it seems not too much to infer (1) that there is next to nothing of pedagogic value the knowledge of which it is safe to assume at the outset of school life. (2) The best preparation parents can give their children for good school training is to acquaint them with natural objects, especially with the sights and sounds of the country. (3) Every teacher on starting with a new class or in a new locality, in order to ensure that his efforts along some lines are not utterly lost, should undertake to explore carefully, section by section, children's minds, with all the tact and ingenuity he can command and acquire; and every normal school pupil should undertake work of the same kind as an essential part of his training. (4) The concepts which are

[1] "Aspects of Child Life and Education," pp. 1–52.
[2] *Ibid.*, pp. 15–17.
[3] *Ibid.*, pp. 23–24.

most common in the children of a given locality are the earliest to be acquired, while the rarer ones come later. This order may generally be assumed in teaching as a natural one, for example, apples first (as appealing directly to the child without mediate process) and wheat last. The order, however, varies very greatly with every change of environment, so that the results of explorations of children's minds in one place cannot be assumed to be valid for those of another, save within very few concept spheres.

It may be stated generally that the extent of the child's knowledge of objects is determined by the frequency of his use of these objects. This corresponds to the Froebelian principle that what the child observes must find expression in action. Almost unknown to the child are those relations which presuppose an understanding of the causal connections of natural processes. In respect to the child's observation it is seen that what is known is what interests; anything which has no interest for the child may be seen a hundred or a thousand times without becoming a mental possession. Whatever plays a part in his protection or defence is especially well known to the child, and what excites pain appears to be more familiar than what excites pleasure.

There is an extraordinary diversity between the mental contents of town and of country children. This difference should be taken into account in teaching, and different primers ought to be provided. Stanley Hall notes[1] that the subject-matter of

[1] P. 24.

primers for town children is in great part still traditionally of country life; hence the danger of unwarranted presupposition is considerable.

From their diagnoses of the child's intelligence, Seyfert and Hartmann conclude that the content of the child's mind on entering school has an influence on later mental development. Children who at the outset appear at a disadvantage in regard to mental content, remain backward throughout the school course;[1] and Stanley Hall affirms[2] that a few days' residence in the country at the age of five or six has raised the level of many a city child's intelligence more than a term or two of school training without this could do.

Seyfert also remarks that children are prone to employ inadequate substitutes for the names of unknown objects. The child tends to substitute the part for the whole, the material for the object; he does not hesitate to coin new words with which to name unknown things or qualities; and he will substitute, spontaneously, the known for the unknown. Some of the misconceptions in the mind of the child, due to the too hasty assimilation of the new to the old, are surprising. The following were disclosed in Stanley Hall's investigations.[3] Butterflies make butter; butter is also said to come from buttercups; grasshoppers give grass; kittens grow on the pussy-willow; all honey is from honeysuckles; and even a poplin dress is made of poplar-trees. The knowledge of this tendency on the part of the child is important pedagogically; and in it

[1] *Cf.* p. 46. [2] P. 25. [3] Pp. 24–27.

there is an advantage as well as a disadvantage. The advantage lies in the fact that when he has to introduce new conceptions and meanings of words it is easy for the teacher to connect them with what is already known; but there is the disadvantage that the new may be interpreted too much after the analogy of the old, and be inadequately analysed and comprehended. This leads to superficiality, to hasty and inadequate perception, and to the substitution of the easy for the more difficult. Hence the maxim—always connect the unknown with the known—may be dangerous. The principle of Apperception has, it would appear, the defects of its qualities.

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CHAPTER VII

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (Continued)

MEMORY

IN considering the subject of memory we must at the outset distinguish clearly between the two forms of memory, viz:

(i) Immediate or primary memory, and

(ii) Prolonged retention, or memory in the usual acceptation of the term.

By immediate memory is understood the direct or instantaneous reproduction of impressions which have not yet been displaced in consciousness by other presentations, that is, there is no interval between impression and reproduction. If a sentence is read aloud to a pupil and he repeats or transcribes it immediately, then primary memory is at work; but if he is required to reproduce the sentence after an interval of an hour, or a day, prolonged retention or memory proper comes into operation. We are justified in regarding these two forms of memory as distinct, since they have entirely different courses of development, and individuals may be variously en-

dowed with respect to them; persons good at memorising may have feeble powers of retention, and *vice versa.*

We can also distinguish particular varieties of memory, termed special memories; for example, memories for objects, sounds, words of certain content, abstract terms, numbers, emotions, ideas, etc. These, again, we may regard as separate memories and not as one faculty operating in different forms, since they develop at different ages and are distinguishable as different traits in individuals, and since one may be destroyed or obliterated without affecting the others.

These special memories are additional to the two divisions, immediate memory and prolonged retention, and may be considered both in respect to the manner of memorising and to the fidelity of their retentiveness. In the first place, then, we shall deal with the development of special memories, and thereafter proceed to consider the nature of immediate memory and of retention proper and the distinctions between them.

Investigations on the development of special memories were first undertaken by the Russian Netschajeff[1] on 687 St. Petersburg scholars aged nine to eighteen; they were repeated by Lobsien[2] in Kiel on 426 scholars whose ages ranged from eight to fourteen. Netschajeff tested the pupils of six institutions of different types, but massed the results; Lobsien avoided this error by confining himself to the scholars of the elementary schools of Kiel.

[1] *Zeitschrift für Psychologie,* vol. xxiv. [2] *Ibid.,* vol. xxvii.

The methods employed in testing the development of special memories are simple. Netschajeff first of all presented twelve different objects, such as are used in observation lessons—for example, handkerchief, pen-holder, book—which were shown to the children, each for two seconds, then they were covered and the pupils were required to write the names of the objects they remembered. This test determines the immediate memory for objects. Next, twelve sounds were produced with different instruments behind a screen—for example, clapping of hands, knocking, tearing silk cloth, stamping, whistling, etc.—and the children had to write from memory what they remembered of the sounds. Then, twelve numbers of two digits—for example, 27, 54, 76—were pronounced, and these, likewise, had to be transcribed. Thereafter, groups of words, invariably trisyllabic, were presented. First, twelve trisyllabic words of preponderatingly visual content, that is, words denoting objects usually apprehended visually by a normal person, for example, pencil, calendar, scissors, bottle, etc.;[1] next, twelve words representing auditory presentations, for example, music, song; then twelve words denoting touch, temperature, and muscular experiences, for example, smooth, round, cold; then emotional terms, as care, joy, hope, sadness, were given; and lastly, twelve abstract conceptions like space, cause, quantity, quality. Lobsien reduced the number of words to nine, but did not restrict himself to trisyllabic terms. The objects were exposed for one second only, and the impressions were required to be written down in

[1] The Russian equivalents were all trisyllabic.

in moral instruction and moral training. As the memory for thoughts seems to be governed by laws differing from those which regulate the memory for sequences of words and sounds,[1] and since more and more is coming to be required of this form of memory —by reason of the changed methods of teaching such school subjects as history and geography—an investigation of the logical or substance memory in school children would be valuable. The memory tests employed by Winch[2] to determine the fatigue involved in evening school work could easily be applied to the development of the logical memory of the school child.

Netschajeff also showed the connection between the memory development and the physical development of the child. He tested the lung capacity and the muscular power of 130 children, and proved that children superior in both physiological functions have also, on the average, better memories. Meumann[3] declares that we are justified in concluding that children of good physique are specially favoured for memory work.

The immediate memory[4] of school children has been tested by Bolton in America, Binet and Henri in France, Schuyten in Holland, Winteler and Meumann in Germany (Switzerland), and by Jacobs,

[1] Watt, "Economy and Training of Memory," p. 33.

[2] *Journal of Educational Psychology*, vol. i. pp. 83–90.

[3] "Vorlesungen," vol. i. p. 181.

[4] On the subject of Immediate Memory, "The Economy and Training of Memory," by H. J. Watt, should be consulted.

Winch, and Lewis in England. The methods were similar in all cases. Bolton read aloud to the children short lists of monosyllabic words, which they were required to transcribe immediately after hearing them; in his tests numbers were also included. Binet used seven series of seven words each and tested 380 school children aged 8 to 13; then sentences which had likewise to be written down were repeated. This method was followed generally by later experiments. Meumann introduced an improvement, investigating the maximum of immediate retention in a more systematic fashion by reading aloud to the children first three, then four, then five, and so on up to eight words, which had to be at once transcribed. This procedure is better adapted to the child; for, if as many as seven words are repeated to a child of eight, they may prove too many and lead to error. In Schuyten's tests at Antwerp, eight numbers of two digits were dictated. Jacobs[1] used nonsense syllables, letters, and single digit numbers. Winch[2] exposed to view sets of twelve consonants for twenty-five seconds, after which they were required to be reproduced in writing. Lewis, for purposes of comparison, used both nonsense syllables and sense words.[3]

The results of these investigations are generally in agreement. The main conclusion is that the child's capacity for immediate retention, or his

[1] *Mind*, xii. 1887, p. 75.

[2] *British Journal of Psychology*, vol. i. p. 128.

[3] "Report of Proceedings of L.C.C. Conference of Teachers, 1910," p. 13 (King, London.)

power of memorising, improves with age, but throughout the whole of school life it is much less than that of the adult. Further, this power develops only very slowly, and at 13 or 14 years of age—just when the elementary school child leaves school—it has not attained its maximum development. Comparative tests of children and adults, applied by Meumann, show that the development of the immediate memory is very slow up to 13 years of age, from 13 to 16 there is a rapid advance, and at 22 or 25 years of age the educated person has attained the maximal power of memorising; after that, a slight retrogression sets in. Meumann found that the effect of practice was not so great with subjects from 30 to 40 years of age as with students from 20 to 25, and that at the age of 40 he himself required for memorising a greater number of repetitions than the best students, although he had had more practice. The first noteworthy decrease of memory power has to be recorded after the age of 50; the decrease with age comes about very slowly, and can to some extent be stayed by continuous training.

Lewis, setting out from the fact that children are at a decided disadvantage in comparison with adults in their power of memorising, believed that children might be compensated for their lower degree of intelligence by an increased endowment in respect of "brute" memory for unintelligible material. He accordingly prepared a series of memory material composed of fifteen monosyllabic sense words—for

example, cut, new, ring, etc.—and a series of fifteen nonsense syllables. Each series was shown three times to the pupil, who was then required to reproduce as many items of the series as he could recollect. The results obtained demonstrate that, with pupils of different ages, namely, 8, 10, and 12 years, the marks obtained were very similar when learning sense words, but the average marks increased with the age of the pupils when learning nonsense material. There is, therefore, no mental compensation, and Lewis infers that the greatest importance should be attached to the clear and systematic apprehension of the form and meaning of the matter which has to be memorised. Much the greater part of the work of memorising, he continues, is effected by explaining carefully to the pupils the matter to be learnt and by cultivating habits of intelligent analysis and synthesis. Efficiency in memory work depends mostly upon the systematic apprehension and the rational comprehension of the significance of the matter. It is this aspect of memory which is capable of most development, and the teacher's efforts in this direction are bound to produce beneficial results. More time should be spent, especially in the lower classes, in the presentation of the matter, and less in mechanical repetition.[1]

The material used for testing prolonged retention or memory proper is, as for immediate memory, nonsense syllables. The advantages and disadvantages of such material are discussed in text books on

[1] "Report of Proceedings of L.C.C. Conference of Teachers, 1910," p. 15 (King, London).

Experimental Psychology.[1] Münsterberg says[2]: "We cannot study the laws of memory if we gather material only from learning poetry with its rich fringes of meaning. The turn to real pedagogy with scientific exactitude came when the memory studies were removed from the living school material, and were performed with the dead stuff of nonsense syllables, all of comparable structure." The usual method of testing retention is to get the subject to memorise a series of nonsense syllables, and after a time to relearn them. Fewer repetitions are necessary to relearn the series, and the difference between this and the original number of repetitions gives a measure of retentiveness. The length of time allowed to elapse between the first and the second memorising must also be taken into account. As stated above, the school-child's capacity for memorising is considerably inferior to that of the adult; with prolonged retention, however, the reverse is the case. Elementary school children retain what is learnt very much longer than the adult, or, in other words, obliviscence progresses more slowly with the school-child than with the adult.

Wessely[3] sought to determine by the following means how much of the memory material of the various school subjects remains and can be reckoned as a permanent possession. He got the pupils of a secondary school from 10–11 up to 15–16

[1] See Myers, "Text-Book of Experimental Psychology," p. 153.

[2] "Psychology and the Teacher," p. 141.

[3] Meumann, "Vorlesungen," vol. i. p. 194.

years of age to transcribe from memory a poem which they had learnt a year before, and thus obtained the amount retained. In a second test he required boys from 9–10 up to 15–16 years of age to learn eight Latin words. The effect of this learning was immediately tested, then again on the following day, then eight days after, and again after four weeks, by exhibiting the German equivalents and requiring the Latin words to be named.

The result of these investigations is that, according to the first test, the pupils' power of retention increased up to 12 or 13 years of age; with the words it increased up to 11 or 12, and from these ages retentiveness and accuracy of reproduction diminished. On one point there is a deviation in Wessely's results from those obtained by Meumann with elementary school children at Zurich. Wessely places the turning-point somewhat later than Meumann; but Meumann ascribes this to difference of training, and adds that the pupils tested by Wessely were not so well practised as the Zurich children, and that Wessely's material was not so well graded as his own.

Since young children who become deaf before five years of age usually also lose their memory for sounds and their power of speech, retentiveness must be very feeble at this age. The curve for retentiveness, then, would rise from the early years up to some point within school life, probably about 14[1] years of age, when it would reach its maximum and then fall; whereas the curve for memorising only

[1] Offner, M., "Das Gedächtnis," p. 288.

attains its maximum at about 25 years of age. The old adage, " Learn young, learn fair," is not justified as regards memorising, but, in respect to retentiveness, the popular view that the child has a better memory than the adult, holds to some extent. The pedagogical conclusion to be drawn from tests of retentiveness would be that formulæ, etc., which have to be continually employed and remembered throughout life, should be learnt at the most favourable age for retention.

With reference to the relation of Immediate to Prolonged Retention, Lewis,[1] in the investigation already referred to, tested the truth of the popular dictum, "Easy come, easy go," which, technically expressed, implies that there is an inverse correlation between immediate memory and retentive power, that those who are efficient in one direction are weak in the other. He had both sense and nonsense material reproduced immediately after being memorised, then reproduced again on the following day. The coefficients of correlation between the immediate and prolonged memory for the sense material were ·64, ·81, and ·76 respectively for the ages 8, 10, and 12; and for the nonsense material the coefficients were ·78, ·75, and ·84 respectively. These results show that the pupils who memorised most on the first day were those who reproduced most on the second, thus indicating that there is no scientific basis for the maxim, "Quickly learnt, quickly forgotten." This conclusion has been independently confirmed by an American experimentalist. Pyle tested, with a pas-

[1] Report of Proceedings of L.C.C. Conference of Teachers.

sage of easy prose, twelve subjects for their rate of learning and for their retention after twenty-four hours. He also found that the most rapid learners showed the highest degree of retentiveness.[1]

With reference to obliviscence, although, as we have stated, children retain better than adults, the rate of forgetting is not the same in both cases. In the interval immediately following memorising (in the first twenty minutes) children forget more than adults do in the same time; then the superiority of children in native retentiveness appears, and they retain better what outlasts this period. Thus we may state, that children receive all impressions and all educational influences with more difficulty than adults, they allow more to escape them in the immediately succeeding periods, but they retain with greater fidelity all that outlasts the first periods of obliviscence.

The improvement due to practice is greater with adults than with children, but the want of practice affects children less. Memorising is unquestionably more influenced by training than is retention. Retention appears to vary with the age and stage of development, whereas learning or memorising is a function greatly affected by training.

As regards the correlation of memory with general intelligence, there seems to be no unanimity of opinion. According to Bolton, memory development does not proceed parallel to development of intelligence, but is dependent on age. Meumann's investigations show that, generally, the more intelli-

[1] *Journal of Educational Psychology*, vol. ii. pp. 311–21.

gent children are also endowed with the better memory. Ebbinghaus, however, using an auditory test, found that the scholars in the lower section of the classes were superior in memory to those more highly placed, thus giving an inverse correlation between memory and intelligence. Winch, on the other hand, employing a visual test, suggests that general intellectual proficiency is usually accompanied by good memory. Burt[1] used concrete words, abstract words, and nonsense syllables, and the pupils not only heard the words but also saw and spoke them. His conclusion is that immediate memory is correlated, to a considerable, but not to a high degree, with intelligence. Meumann's claim that superiority of abstract memory to concrete memory is a strong mark of intelligence is not confirmed by Burt's results.

The contradictory nature of these conclusions indicates that this question demands further investigation whenever satisfactory methods for determining general intelligence have been devised. Since general intelligence is doubtless involved in the majority of memory tests—as Lewis' results go to prove—it may be that in attempting to estimate the degree of correlation, we are merely working in a circle.[2]

With reference to the formal training of memory, the ordinary school training does not affect the power of memorising to any considerable extent, but, according to Meumann, when the pupil is subjected to artificial exercises the improvement is most marked.

[1] *British Journal of Psychology*, vol. iii. p. 143.

[2] *Cf.* Myers, "Pitfalls of Mental Tests."

It has consequently been concluded that exercises in formal training of memory should be introduced into schools. Van Biervleit, the Belgian psychologist, for example, advocates this; but Meumann opposes it, believing that school instruction should for formal training make more use of the material it has to hand and that the systematic introduction of purely formal exercises is undesirable. Such exercises, he remarks, demand much time, and would burden the curriculum, and it is doubtful whether this addition to the curriculum would be compensated by the gain in formal training.

From investigations conducted by Winch[1] it would appear that improvement through practice in rote memory, with and without meaning, is followed by improvement in substance memory for stories. But, like Meumann, he suggests that pedagogically the fact of "transfer" should not lead us to adopt indirect or formal training methods, unless the improvement thereby transferred is greater than that to be obtained by direct attack on the matter really required to be known.

The most recent investigation of the subject by Sleight, seems, however, to indicate that there is no such transfer,[2] and it is even suggested that some forms of practice may have the effect of diminishing the power to memorise other material.

[1] *British Journal of Psychology*, vol. iii. pp. 386–405. *Cf. Journal of Educational Psychology*, vol. i. p. 588.

[2] "Memory and Formal Training," *British Journal of Psychology*, vol. iv. pp. 386–457. For Summary see *Journal of Experimental Pedagogy*, vol. i. pp. 51–54.

No justification for the older forms of formal training is consequently to be obtained from recent experimental investigation.

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CHAPTER VIII

THE DEVELOPMENT OF THE SPECIAL MENTAL POWERS OF THE CHILD (Continued)

MENTAL ASSOCIATION AND IMAGINATION

"TO understand the interplay of ideas," says Münsterberg,[1] "in all these activities, such as memory and expectation, knowledge and reasoning, imagining and creating, it becomes necessary to know something of the raw material in the pupil's mind. The association of ideas is in itself, accordingly, neither thinking, nor imagining, nor remembering, nor expecting. But the association of ideas furnishes the supply for all these purposive activities, and particular kinds of associations must favour or oppose these various performances." For this reason the subject of Mental Association claims attention here, because it is through the application of tests fashioned on the lines of the association tests that the problem of the psychology of thinking has been most successfully attacked.

A frequent objection to the association tests in

[1] "Psychology and the Teacher," p. 151.

Experimental Psychology is that the response to a given stimulus word may be accidental, varying with the occasion, and consequently of no value as an index of the mental content and endowment of the subject; but a careful analysis of the nature of the responses of subjects discloses not only interesting individual differences, but also characteristics from which may be inferred the mental type to which the subject belongs.

Association tests may be divided into the two main classes, "free" and "constrained" associations.[1] In free association tests a word is presented to the subject, and he may reply with any term he pleases, for example, "horse—cart." In constrained association tests the subject's choice of response is restricted to a definite class of terms. He may be asked to give the super-ordinate, that is, the class to which a certain thing belongs, for example, "apple—fruit"; or he may be required to state the cause, say, of the rainbow. The latter type of association approximates more closely to actual conditions of thinking and will probably be more extensively applied in the future.

Association tests may be applied to subjects individually, or may be dictated to groups or classes. The former method allows the reaction times and the introspection of the subjects to be ascertained, if desired.

The first important work on Mental Association in school children was undertaken by Ziehen at

[1] "Uncontrolled" and "controlled" are alternative terms used, *e.g.*, by Whipple, "Manual of Mental and Physical Tests," ch. ix.

Rein's Seminar School in Jena about 1898.[1] He applied individually to forty-five boys, from 8 to 14 years of age, free association tests, his object being to prepare an inventory of the mental images of each pupil and to determine the rate of association and the nature of the imagery aroused by the given stimulus words. The choice of stimulus words was arbitrary, and the boys were required to respond as quickly as possible.

Ziehen concludes from his results that the rate of association is quicker with the adult than with the child, and that the speed of association increases markedly year by year. He found no appreciable difference in rate between subsumed and generalised or superordinate associations. Verbal associations, implying merely an alteration in the form of the given word or the return of a given word of similar sound to the stimulus, are said to be considerably quicker than associations in which the response is the name of an object; and the average association time is longer, the more accurately the mental image is spatially and temporally defined. Verbal associations, however, seldom occurred with children, and they generally took the form of word completion, for example, "market"—"market-place." Verbal association appears to increase with age and is most frequent with adults: rhyme associations also occur more frequently with adults, and similarly associa-

[1] "Sammlung von Abhandlungen aus dem Gebiete der pädagogischen Psychologie und Physiologie," vol. i. Part 6 und vol. ii. Part 4. For summary of Ziehen's experiments see Meumann's "Vorlesungen," vol. i. p. 220 ff.

tions of words commonly connected, for example, "hand—foot."

The characteristic of "perseverance," by which, psychologically, is understood the repetition, usually inappropriately, of a term previously used in the investigation, was observed by Ziehen; but although remarking that it decreases with age, he did not attach to it as much significance as later writers.

Meumann applied free association tests with over 800 children of the elementary schools of Zurich. The tests were naturally "mass" experiments, the class teacher reading aloud lists of words and the pupils writing the first other word that occurred to them. In these mass tests the times could not be determined, but in the upper classes the whole investigation went appreciably quicker than in the lower classes; and with fourteen-year-old children frequently only half the time taken by the eight-year-old children was required.

From his results Meumann concludes that wealth of imagery and originality of reproduction, without, however, any departure of the subject from the type proper to his stage of development, are characteristics of intelligence. The former is displayed in change of categories—object-reproductions alternating with qualities and processes; the latter is shown in the response of a term like "fuel," instead of the usual reply "black," to the stimulus word "coal."

Associations which arouse object-images preponderate with young children, verbal changes with older pupils. When about the thirteenth or fourteenth year concrete imagery fails, the pupils take to

reproducing the logical opposite, for example, "hot—cold." This form of reproduction, especially the use of correlatives, is usual with the less intelligent children and is the quickest form of association with adults. Unintelligent children reproduce words frequently named together, and depend much on what has been learnt at school for the material as well as the form of reproduction. With younger children visual reproductions preponderate and auditory are in comparison remarkably rare; with older children the images derived from the various spheres of sensation are more evenly distributed.

Meumann distinguishes three forms of "perseverance," viz.:—

(1) When a previous stimulus or reaction word repeats itself where inappropriate;

(2) When a certain form of expression keeps recurring;

(3) When a certain type of relation, for example, oppositional or adjectival, determines the reproduction.

The following examples from the present writer's investigation[1] may illustrate the foregoing:—

(1) Basket—handle; Sword—handle; Door—handle; Cup—handle.

(2) An extreme case—that of a boy of $7\frac{1}{2}$ years of age who, owing to his helplessness in the face of abstract terms, gave in a series of ten the following: Disgrace—I am in disgrace; Greed—I am greedy; Sadness—I am in sadness; Danger—I am in danger; Deceit—I am full of deceit; Liberty—I am full of

[1] *British Journal of Psychology*, vol. iii. p. 368.

liberty; Honesty—I am full of honesty; Honour—I am full of honour; Beautiful—I am beautiful; Bravery—I am in bravery.

(3) Adjectival form: Hat—Black hat; Lamp—Brass lamp; Cherry—Red cherry; Hill—Green hill; Castle—Big castle; Boot—Black boot; Snow—White snow; Butter—Yellow butter; Board—Brown bread board.

Oppositional form: In a series of ten, another subject gave, Gladness—Sadness; Honour—Dishonour; Honesty—Dishonest; Disgrace—Graceful; Sadness—Happiness; Greedy—Ungreedy.

This last example indicates the power of the type of relation over the nature of the reproduction. Such "perseverance" Meumann regards as a definite characteristic of low intelligence.

Winteler has tested individually for reproductions, both free and constrained, eight boys about ten years of age. The times were measured with a Hipp's Chronoscope, but the introspective data obtained were practically valueless.

In "free" reproduction two pronounced types emerged. One class reacted to substantives with an attributive adjective, to adjectives with a complementary substantive; this constitutes the perceptual or describing class. The other responded to a substantive with another substantive standing in logical relation, to an adjective with a contrary adjective, to a verb with a contrary or a synonymous verb; and this constitutes the comparing or relating type. No relation was apparent between the type and the degree of intelligence. In consequence of

the limited number of Winteler's subjects a reinvestigation of this classification might be desirable.

Winteler arranged his constrained associations under the following heads, to find (1) a superordinate concept for a given concept, (2) a subordinate concept, (3) a co-ordinate concept, and to give (4) an example or species of a genus, (5) an opposite. He concluded from the reaction times that of the three tests, to find a superordinate, a co-ordinate, or a subordinate concept, the first entails the greatest, and the last the least logical effort. The shorter reaction times occur with the more intelligent subjects, yet the rate of reproduction possesses only secondary value for estimating the grade of intelligence.

The present writer reinvestigated the subject of mental association with twenty-two boys from 7½ to 14½ years of age. Both free and constrained associations were used, and special attention was paid to the following points: the relation of the speed of reaction to the age of the subject; the effect of practice on the rate of reaction; the order of difficulty as indicated by the speed of reaction of the various processes; the relation, if any, of the nature of the responses to the standard of intelligence; the various forms and the degree of perseverance; the nature of the child's imagery, its relation to age and intelligence; and the part played by imagery in constrained association.

The reaction times were measured with a stop-watch, the subject being thus unaware that he was being timed. The usual instruction given in such tests has been to answer as quickly as possible;

since, however, the introspective account was considered the more valuable aspect of this investigation, the pupils were instructed to take their own time but to give the first word that occurred to them or to indicate whenever an image was aroused in the mind. Two quite different forms of attunement, according to Meumann, who used it with adults, result from this difference in the form of instruction. When rapidity of response is the controlling factor, the stimulus word is, he declares, comprehended after the most fleeting fashion; the reproductions are of little value—rhymes, word changes, opposites, etc.; the times are shortened; the statements regarding the processes intervening between the apprehension of the stimulus and the response are incomplete; and often the subject knows nothing of how he arrived at the reproduction. With the other form of attunement, however, these characteristics are reversed. Meumann maintains, therefore, that for tests with a problem to be solved the instruction "as quick as possible" is detrimental. This difference in attunement may have educational significance; the best results may not be obtained from pupils highly attuned to rapid answering.

The results of the present writer's investigation indicated that, for different children, the speed of association bears no direct relation to age, and has little value as an indication of the intelligence of the subject. It also disclosed great individual differences in the rates of reaction. For example, the investigation began with three boys of the same age and intelligence. By timing them with the stop-watch

it was found that one of the boys invariably took three times as long as the other two to respond to the stimulus words. He was quite as intelligent as his companions, and the work presented no difficulty, yet his normal rate of reaction was considerably slower. The suggestion has been made that modern language teaching might one day be tested by presenting terms in the foreign language and noting the reaction times taken by the subject to respond with the English equivalents; but in view of the individual differences now disclosed by experiment this proposal is not likely to be adopted.[1] Reaction times have also been proposed as a means of discovering whether a pupil has been implicated in some misdemeanour. When a subject's normal rate of response has been determined, a belated reaction may be interpreted as indicating mental confusion. In the investigation just referred to, one pupil, whose normal rate of response, judged by the median, was 3·4 seconds, took 13·8 seconds to respond to the word "Beauty." On cross-examination, however, he admitted, not

[1] *Cf.* Cattell (quoted by James, "Principles of Psychology," vol. i. p. 559), who writes: "The rate at which a person reads a foreign language is proportional to his familiarity with the language. For example, when reading as fast as possible the writer's rate was—English 138, French 167, German 250, Italian 327, Latin 434, and Greek 484; the figures giving the thousandths of a second taken to read each word. Experiments made on others strikingly confirm these results. The subject does not know that he is reading the foreign language more slowly than his own; this explains why foreigners seem to talk so fast. This simple method of determining a person's familiarity with a language might be used in school examinations."

without blushing and stammering, that he had first thought of one of the girls in his class and had not wished to say so.

The most important fact revealed by a study of reaction times is that the rate is slower with the child than with the adult; in some cases, it has been asserted, the child takes almost ten times as long as the adult to respond to the same stimulus. From this we may infer that the rate of questioning in schools is probably too rapid and, as the writer has elsewhere suggested,[1] that the determination of the *tempo* of questioning, for different ages and classes of children, would accordingly be a useful contribution to Experimental Education.

The order of difficulty of the various processes, judged by the rate of reaction, seems to be as follows: whole—part (*e.g.*, chair—leg) being easiest; then part—whole (*e.g.*, leg—table); co-ordination, knife—fork; free concrete associations, dog— ; super-ordination, dog—animal; subordination, animal—horse; free abstract associations, honesty— ; and, most difficult of all, causal relations.

Meumann[2] has concluded, from his examination of the mental content of children entering school, that what excites pain appears to be better known than what excites pleasure; but, judged by the rates of reaction to the respective classes of terms, no principle can be established.

Analysis of the responses of pupils demonstrates

[1] "Experimental Education," *Journal of Education*, December, 1910.

[2] "Vorlesungen," vol. i. p. 151.

that in finding the superordinate to a given concept the more intelligent children give the genus immediately above the given concept, for example, violet —flower; whereas the less intelligent give a genus more remote, say, violet—plant. This is doubtless due to the fact that with the former the system of knowledge is better articulated.[1] This characteristic might, like "perseverance," be used to determine the general intelligence of pupils.

In his investigation of mental association Ziehen sought to determine the imagery in the pupils' minds accompanying the association processes. He states, regarding the nature of the child's imagery, that he was prepared for a preponderance of individual images, but the extent to which this occurred astonished both himself and all to whom he communicated his results. He consequently concluded that the mental imagery of the child differs *toto coelo* from that of the adult.

By adopting the new form of attunement referred to above, and by leaving the subject free to indicate when an image was aroused in the mind, not requiring him to respond necessarily with a word, the present writer was able to determine somewhat more fully than previous investigators the nature of the child's imagery accompanying association processes, both "free" and "constrained."

Sometimes it is asserted that young children cannot introspect; but when once it is explained to pupils of school age what is expected of them they

[1] In the development of the child's speech the general class term appears earlier than the specific.

usually experience no difficulty in giving introspective detail. For example, a boy of seven and a half years of age stated that when the word "cruelty" was given, he seemed to see two fellow-pupils who had "got a good scolding from the teacher" on the previous day; "they seemed to be in school with red faces," he said. In the case of silver—gold, he stated that he thought of the song—

> "I'll give you silver
> And I'll give you gold."

The variety of detail in the imagery of children is quite astonishing. A stimulus word may arouse not only visual imagery but auditory, tactual, etc.; and the majority of images have definite spatial and temporal localisation. So vivid, indeed, may be the imagery in some instances that whatever is in the field of perception against which the image is projected, is obliterated. The child's imagery has in a high degree the characteristics of direct perception, and it is doubtless for this reason that the child readily confuses the two spheres, which for the adult are quite distinct. This has led Ziehen to affirm that, in respect to imagery, the mental association of the child differs entirely from that of the adult.

Meumann has, however, found amongst adults (chiefly students) a certain percentage with whom abstract terms were always accompanied by a surprisingly lively concrete content. He maintains that this concrete content has with the adult quite another significance than with the child; for whereas it often forms the only content of the words for the child, for

the adult it serves only as a connecting link and support of the logical relations which constitute the essential content of the word.

We are, indeed, inclined to believe that the feature distinguishing the imagery of the child from that of the adult is the relevance or the irrelevance of the imagery. Bradley[1] gives the following instances of irrelevant imagery: "Should we be asked, Are roses red? Has coal-gas a foul smell? Is that white beast a horse? Is it true that he is dead?—we should answer, 'Yes.' But the redness present in consciousness may have been that of a lobster, the smell that of castor-oil, the imaged horse may have been a black horse, and death, perhaps, a withered flower." This might be so with adults, but in the present writer's investigation, when 110 tests were made with each of twenty-two boys, in no case could the imagery be described as irrelevant.

The first main classification of images is into concrete and verbal; and it may be said in this connection that the child's imagery is mainly concrete and the adult's mainly verbal; only about two per cent. of the imagery of pupils of school age is verbal.

It is not infrequently maintained that, as we have general ideas, we must consequently have some form of imagery corresponding thereto, usually termed "generic" imagery. That we have power to construct images answering to various requirements is certain, and it seems as if a pupil of limited experience may have compensation in the

[1] "Principles of Logic," p. 9. Quoted by Stout, "Analytic Psychology," vol. i. p. 50.

form of special ability for constructing imagery, but we do not seem to be capable of constructing images answering to general ideas. Galton, in his "Inquiries into the Human Faculty," gives, in illustration of these "generalised mental images," a case where a speaker says[1]: "The boat was a four-oared racing boat; it was passing quickly to the left just in front of me, and the men were bending forward to take a fresh stroke." "Now at this point," he says, "the listener ought to have a picture well before his eyes. It ought to have the distinctness of a real four-oar going to the left, at the moment when many of its details still remain unheeded, such as the dresses of the men and their individual features. It would be the generic image of a four-oar formed by the combination into a single picture of the great many sight memories of those boats." Nothing resembling a "composite" image corresponding to a general idea is to be found in children's thinking nor, we believe, in adults' thinking. In some cases the images are very vague, but unless mere vagueness is held to constitute generality, it may almost be said that with school children no generic imagery exists.[2]

Thought, in so far as it is implied in constrained associations, is possible without images in the case of children. This seems to be most frequent when the terms are familiar; but where imagery is present the image may attach to only one term of the association, and the course of imagery may be opposite to the sequence of thought.

[1] Everyman Edition, p. 77.

[2] *Cf.* Stout, "Analytic Psychology," vol. i. pp. 82–85.

It is sometimes maintained that, in teaching, appeal should be made to all the senses; but this does not seem to be confirmed by investigations, for children who are best endowed in the various forms of imagery do not necessarily stand higher in the class than those with only one form. Betts,[1] from his study of mental imagery with college students, also concludes that there seems to be an entire absence of correlation between ability in imagery and ability in college studies. Watt consequently maintains[2]: "It must be emphasised that there is not the slightest use in multiplying forms of imagery in the process of learning. . . . Energy should be concentrated on one method so that it becomes reliable." The visual is undoubtedly the preferred sense in respect to imagery, the auditory coming next, but the auditory images are only about 20 per cent. of the visual.[3]

An interesting phenomenon which emerged in the present writer's investigation of the imagery of children has been termed self-projection.[4] R. L. Stevenson describes it, in a passage referring to the

[1] Betts, "The Distribution and Functions of Mental Imagery," p. 48.

[2] "Economy and Training of Memory," p. 101.

[3] *Cf.* Colvin, S. S., and Myers, E. J., "The Development of Imagination in School Children," *Psychological Review*, Monograph Supplement, vol. xi. p. 123: "It seems to be established beyond reasonable doubt that the young child thinks largely in concrete visual imagery, and that while auditory and motor imagery are present to some degree, they play a relatively unimportant rôle in the lower school grades."

[4] *British Journal of Psychology*, vol. iii. p. 379.

imagery in children's thinking, which we make no apology for quoting.

"Rummaging in the dusty pigeon-holes of memory," he writes,[1] "I came once upon a graphic version of the famous Psalm, 'The Lord is my Shepherd,' and from the places employed in its illustration, which are all in the immediate neighbourhood of a house then occupied by my father, I am able to date it before the seventh year of my age, although it was probably earlier in fact. The 'pastures green' were represented by a certain suburban stubble field, where I had once walked with my nurse, under an autumnal sunset, on the banks of the water of Leith; the place is long ago built up; no pastures new, no stubble fields; only a maze of little streets and smoking chimneys and shrill children. Here in the fleecy person of a sheep, I seemed to myself to follow something unseen, unrealised, and yet benignant; and close by the sheep in which I was incarnated—as if for greater security—rustled the skirts of my nurse. 'Death's dark vale' was a certain archway in the Warriston Cemetery; a formidable yet beloved spot, for children love to be afraid—in measure as they love all experience of vitality. Here I beheld myself some paces (*seeing myself, I mean from behind*) utterly alone in that uncanny passage; on the one side of me a rude knobby, shepherd's staff, such as cheers the heart of a cockney tourist, on the other a rod like a billiard cue, appeared to accompany my progress; the staff sturdily upright, the billiard cue

[1] "Essays of Travel: Random Memories."

inclined confidentially, like one whispering, towards my ear."

This reflexive attitude—the seeing oneself from behind, as Stevenson describes it—is surprisingly common in the imagery of school children. With some pupils it occurs in almost every image, and it appeared in a pupil as young as seven years of age. The existence of this phenomenon in the imagery of young children will doubtless influence the current explanation of the development of self-consciousness in the child.

A study of children's imagery will help to chasten the teacher's opinion as to the importance of the school in education. Life, we are often told, is the best school, and wisdom keeps school outdoors; and while one may be reluctant to enter an apology for idlers, it cannot but be admitted that the investigation of children's imagery, to which reference has already been made, proved that practically all the imagery with which children ordinarily do their thinking has been acquired elsewhere than at school. In fact, the real season of education seems to be during the holidays. All the school does is to organise and systematise those outdoor experiences.

The course of imagery forms the basis of the child's imaginative activity. By dissociating the images from the given material of perception and forming from them new combinations, the child acquires the first mental possession which, along with recollection, is his very own. His imaginative activity animates his play, personifies all the objects and processes, and transfigures all actions and

individuals in his environment; but it likewise enters into his recollections and affects his testimony, occasioning what are termed "children's lies."

By imagination is understood that play of our reproduced presentations which, on the one hand, does not directly subserve the recall and recognition of objects, and, on the other hand, does not possess the character of logical thinking; it is a free and independent activity. Its characteristics are that the imaginative content interests us for its own sake and acquires a certain independence; the images likewise tend to become dissociated from the order in which they were originally acquired and to form new combinations. In thinking, the content of the images does not interest us for its own sake, and the function of imagery in thinking is merely to reinforce and sustain logical connections.

Imaginative activity is said to be passive and relatively unsystematic when, for example, the individual has no definite aim, but gives himself up to reverie; or it may be active and systematic, if regulated by a definite aim which fixates the attention and determines the selection of what is reproduced. Imagination may be distinguished as concrete or perceptual and abstract: it may be lively, working with clear and distinct images, or hazy and dull, working with indistinct imagery: merely reproductive or constructive; and the constructive imagination may be highly productive or poor and unfruitful. These oppositions are not necessarily exclusive, and the distinctions, being partly conditioned by the process in which they appear, and

expressing themselves at different stages in the individual's development, are only relative.

The child's imaginative activity has the following characteristics, which are the more pronounced the younger the pupils are. It is more passive and roving than active and systematic, more concrete than abstract, more subjective and uncritical than controlled by critical judgment. For this last reason it appears to be lively and productive; this productivity is not, however, due to wealth of imagery and power of original combination, but, like many of the child's other seeming advantages, it is really a defect, arising out of the child's uncritical judgments and estimate of his own imaginative constructions and his lack of the subordination of these to observation and recollection. The child's imaginative activity is preponderatingly reproductive and imitative. Although his imagination is not active in the sense of being creative, the child has nevertheless a strong impulse to use imagination.

His imagination is not, however, merely imitative; even in his play the personifying tendency of imagination creates new situations and assumes new forms. Herein lies its pedagogical significance. It supplies the sphere in which the child's mental independence, his joy of discovery, and his capacity for invention can first be aroused and exercised, and thus serves as a field for awakening in the child ideas of self-dependence.

The fact that the child naturally expresses in action his imaginative conceptions, and that his imaginative world has not the intimate and secret

character of that of the adult, removes an objection frequently raised against children being allowed to exercise their imagination. The danger of imagination lies nevertheless in the facility with which the child can employ it; it tends to become a substitute for, and to subordinate to itself, perception, recollection, and judgment. There results the natural confusion of the imaginary with the actual, and the consequent so-called "children's lies." These should be treated as practical difficulties, not as ethical misdemeanours, and the child should be brought to see that the distinction between the true and the false is a serious affair in practical life.

Education should seek to secure that imagination is based on adequate analysis of objects of perception, and that it is subordinated, through training in attention and judgment, to perception and recall, both in observation and in testimony.

There are various methods of investigating imagination experimentally. In addition to the reproduction method, described above, investigations of testimony may be used, and, with young children, interpretation of schematic and of incomplete drawings, gradually increasing in difficulty. All forms of combination or completion tests will be found serviceable, where the pupil is required to fill in words elided from a text; to form sentences embodying given words; or to complete stories, parts only of which have been related. When further investigations have been carried out by these means more definite conclusions on the development of the child's imagination will be possible.

The child's thinking, which depends partly on his use of imagery, has so far been but little investigated. The variety of the views on the child's reasoning powers instanced in our introductory chapter will indicate how far we are removed from a scientific knowledge of children's thinking. Further investigations of the "constrained" association type illustrated above, and on the lines introduced and applied by Watt on adults,[1] will doubtless lead to exact knowledge of this subject.

[1] Watt, H. J., "Exper. Beiträge zu einer Theorie des Denkens," *Archiv. f. d. ges. Psychologie,* Vol. iv.

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CHAPTER IX

THE ÆSTHETIC AND ETHICAL DEVELOPMENT OF THE CHILD

EMOTIONAL AND ÆSTHETIC DEVELOPMENT

THE emotional and volitional aspects of the child's mental development have, in comparison with the intellectual, until recently been largely neglected by both analytical and experimental psychology, and the experimental methods have not to any considerable extent been applied to children. This neglect has been attributed by McDougall [1] to the reliance of psychology on the method of introspection. "The psychologists, endeavouring to define their science and to mark it off from other sciences, were led to accept a too narrow view of its scope and methods and applications. They were content for the most part to define it as a science of consciousness, and to regard introspection as its only method; for the introspective analysis and description of conscious states was a part of the proper work of psychology that had not been undertaken by any other of the sciences. The insistence upon introspection as the one method of the science tended

[1] "Social Psychology," pp. 6–7.

to prolong the predominance of this narrow and paralysing view of the scope of the science; for the life of emotion and the play of motives is the part of our mental life which offers the least advantageous field for introspective observation and description. The cognitive or intellectual processes, on the other hand, present a rich and varied content of consciousness which lends itself well to introspective discrimination, analysis, and description; in comparison with it the emotional and conative consciousness has but little variety of content, and that little is extremely obscure and elusive of introspection."

The problems of the life of feeling have been approached by two methods, namely, the "stimulus" and the "expression" method respectively. The stimulus methods attempt to determine in what manner and to what extent feelings are dependent upon the quantity, quality, or combinations of sensory stimuli: stimuli of like quality, but of different intensities, are allowed to act upon the individual, and the effect of the resultant feeling is noted, or investigations are made of the emotional reactions to sensations of different quality, or the æsthetic effects of certain combinations of stimuli are estimated, for example, of lines divided in various proportions, or of lines of different form, serrated or sinuous, or of colours. With the expression methods, either there is fixed photographically the facial expression or bodily posture under certain conditions of feeling, or more usually a graphic record is taken on a smoked rotating drum of the various physiological processes which accompany changes of feeling

—for example, variations in the character and rate of the pulse beat, or respiration, the size of the pupils of the eyes, the volume of the limbs, or the energy and rate of movement.[1]

An indirect means of investigating the emotional and volitional development of the child is to be found in the child's judgments of value, æsthetic and ethical, as distinguished from his logical judgments. In so far as children can appreciate and pass such judgments—for instance, beautiful and ugly, good and bad—it is evident that their æsthetic and ethical senses are awakened; and their testimonies as to such values are of great importance as indications of general development and, in particular, of the development of feeling and will.

So far we know but little of the child's affective moods, emotions, and sentiments. From various observations all that we have learned is that the younger the child the more unstable is his emotional life—passing swiftly from one mood to the opposite. Emotional states are also easily suggested to children; as with feeble-minded persons, both old and young, various moods can be readily induced or inhibited in children.

Of the special feelings, the æsthetic have been investigated most. Letters, figures, various forms of writing, etc., have been presented to children, who have been required to judge which form they preferred. Meumann has also tested children from 7 to 14 years of age with the usual æsthetic tests,

[1] For methods see Myers, "Text-Book of Experimental Psychology," ch. xxv.

getting the pupils to arrange a series of colours in order of preference, and also to judge of their combinations in pairs; the pupils were likewise required to give judgment on divisions of lines, and on triangles and quadrilaterals with sides variously proportioned. These tests showed that, generally, the colour and dimension judgments were very definite, whereas with the younger pupils the divisions of lines were often a matter of indifference. The favoured colours were blue, red, and yellow; adults, however, seldom preferred yellow. The colour combinations were generally given after the same fashion as with adults, those lying nearest the contrast colours being the least pleasing. The difference in the æsthetic sense of the sexes was generally confirmed; girls showed more appreciation for colours, boys for form.

A mass method, not without objection perhaps, but one which has the merit of simplicity and has produced interesting results, has been employed by Winch [1]: he sought to determine which of the simple colours were preferred by school children; whether the preferred colours changed as the children advanced in age and intellectual proficiency; and what was the effect on colour preference of sex, social status, and colour work done in school. The following words were written on the blackboard—White, Black, Red, Green, Blue, Yellow; and the children were required to write on a slip of paper the name of the colour which they liked best or considered the prettiest, thereafter the next colour they would choose, and so on.

[1] *British Journal of Psychology*, vol. iii. pp. 42–65.

Taking first the results from girls' schools alone, we find that blue in all cases takes the first place, black invariably the last. Red usually comes second, but in a school of very high type it fell to third place and with adult women to fourth place. Yellow generally takes third place at the outset of school life, but drops to fifth place with advancing age, at a rate apparently dependent on the mental proficiency and social status of the pupils. Green usually takes the penultimate place to begin with, but rises steadily as the pupils advance in culture; in a school of high social status it was a pronounced feature in all standards, but it rose very little, if at all, in a school situated in a poor neighbourhood. With adult women green easily takes second place. Winch accordingly suggests that a preference for green may probably be a characteristic of fairly high mentality. White, in the case of girls, usually oscillates between the third and fourth positions.

With boys, as with girls, blue is normally the first choice, but red competes more keenly for the place of honour and in some cases even takes first position. Black is always at the bottom, and white next to it —which is a lower position than with girls. Yellow begins with the second or third place and consistently falls to the fourth, whereas green, after rising throughout with advancing age and mental proficiency, attains premier place with male adults.

From his investigation Winch concludes that colour preferences show regular changes in definite directions as children advance in age and mental

proficiency; that there are some differences of a constant nature between male and female preferences; that there is evidence of the development of preference depending on social status; that there is no evidence of colour preference being influenced by colour work in schools; and that colour preference appears to be a function of general mental proficiency rather than of age. It is also suggested that the preferences indicated should be taken into account when constructing school appliances for the various classes.

Bullough [1] has sought to determine whether differences of æsthetic effect can be explained by differences in the perception of single colours, and the application of his method to school children might be interesting. His investigation enables him to classify his subjects into four perceptive types:—

(1) A group which represents the *objective* aspect, describing colours as thin, poor, hard, warm, soft, etc., these terms having reference to the nature of the colours themselves and not to the effects produced on the subjects.

(2) A group which represents features producing certain effects on the subject, such as stimulating, soothing, energetic— an aspect which might be termed the *physiological*.

(3) The third group represents the suggestive power of colour or its *associative* aspect, for example, a colour might suggest a sunset, a railway signal, or a medicine, and be liked or disliked accordingly.

(4) The fourth type represents the very subtle and

[1] *British Journal of Psychology*, vol. ii. pp. 406–63.

divergent features of "temperament" or "character"—the *character* aspect. By the "character" or "temperament" of a colour is meant the appearance in a colour, or the expression by a colour, of what in a human being would be called his character, mood, or temperament. Extreme examples occurred when an orange colour was described by a subject of this type as "trying to be what it isn't"; and a blue-purple was described by another such subject as "a person with a past." It would be interesting to know whether school children exhibit such typical differences, or if other perceptive differences determine their colour preferences.

At Meumann's suggestion, Albien at Königsberg submitted to a number of boys, aged seven to eighteen, two pictures for their æsthetic judgment, one representing an emotional scene, the other a mere realistic incident. The pupils were required to state in writing which they considered the more beautiful, and why. It was discovered that the number preferring the emotional picture increased with advancing age; at the same time Albien found that the judgments of scholars were rarely passed on the formal elements of the artistic representation, but almost always on the content, just as with adults æsthetically uncultured. To enable children to pronounce a valid æsthetic judgment, that is, a judgment on the form and not merely on the content, more training in real æsthetic appreciation and a wider knowledge of the production of works of art are necessary; the chief æsthetic value of instruction in drawing and modelling lies in the fact that such instruction is what

first discloses to the pupils, from the point of view of technique, the nature of a work of art as such.

By inquiring of children as to the feelings aroused by decorative objects, such as a cupboard, chair, etc., Meumann has determined that real æsthetic judgment cannot, for a considerable time, be expected of children. He frequently found that children of the first school year ignored the æsthetic form or the decorative aspects and regarded objects according to their utility or conspicuous features. Whereas for the young child of school age æsthetic appreciation of works of art and of decoration is impossible, the elementary æsthetic relations—colours, tone combinations, simple melodies, strongly defined contours and forms of objects—are readily apprehended by the child.

Dierks has also demonstrated that his pupils gave practically no attention to placards and wall texts, and we may from this conclude that children cannot be expected to develop æsthetic appreciation without training. The same fact is indicated by the results of an experiment by Professor O'Shea in the schools of Dakota. The pupils were required to draw decorative objects, and it was found that the youngest children omitted all decorative detail and drew only the utensil as such; of the eight-year-old children, about 50 per cent. endeavoured to include the ornamental, and of the sixteen-year-old pupils about 87 per cent. reproduced the ornamental.

From the experiments of Schulze, who photographed the facial expressions and the gestures of children in the presence of pictures, nothing can un-

fortunately be inferred as to the æsthetic judgment of the child. These experiments only indicate that children allow themselves to be influenced by the content of the picture, not that their feelings are aroused by the artistic elements of the representation; for children, a picture is not an æsthetic experience but a mere object.

Fr. Lichtenberger investigated the preferences which children of various ages show for melody and rhythm. The results indicate that the difference in the emotional effects of melodies and rhythms is not so marked with children from six to eight years of age as with nine year old children; at nine a definite discrimination for both factors of the emotional effect of music appears, and continuous rhythm seems to have more emotional value than melody. It is also interesting to note from these investigations that with children the memory for rhythms has been proved to be better than the memory for tones.

VOLITIONAL AND ETHICAL DEVELOPMENT

Perhaps no question is having more attention directed to it at the present time in educational circles than that of moral education, and the variety of opinions expressed makes one despair of education ever becoming in any sense scientific. As to what should be taught or how it ought to be taught, there is no agreement; individual opinion runs riot through the numerous reports on the subject.[1] One writer maintains that in direct moral instruction lies the

[1] *Cf.* "Moral Instruction and Training in Schools."

nation's only salvation, another declares that the best results can only be obtained by indirect or incidental teaching; one insists that morality demands religious sanctions, another that moral instruction should be independent of religion; one asserts that all subjects can be turned to account in moral teaching, another that only certain specific subjects are of value.

To the Child-Study movement we owe most of our knowledge, general as it is, of the ethical development of the child. The contribution of Experimental Education is as yet small; but although the methods employed may seem indirect, they are opening up a field where there is at least some hope of harvest.[1]

Children's interests, aspirations, and ideals have been investigated by Child-Study methods, and the results are not without value.[2] The pupils are required to answer, giving reasons for their answers, such questions as, "What would you like to be when you are grown up?" "Who is your ideal person?" "What is your favourite subject of instruction?" "Who is your favourite author?" "What is your favourite game, activity, or amusement?" The investigations have been carried out in England, America, Germany, Austria, and Switzerland, and the results are valuable, not only as affording material for judging of the development of the whole spiritual

[1] *Cf.*, for example, for application of experimental methods to volitional processes, E. Boyd Barrett, "Motive-Force and Motivation-Tracks. A Research in Will Psychology."

[2] For summary, see King, "Psychology of Child Development," chaps. xi.–xiii., and for criticism of methods ch. xiv.

nature of the child, but because they provide us with standards whereby we may compare the various educational systems and estimate the power of the school in furnishing the pupils with ideals. The treatment of the results takes two forms: one statistical—an enumeration of the persons, authors, games, etc., preferred, the other psychological and pedagogical—the analysis of the reasons given and the relation of these to the general development of the child on the one hand, and to the subjects and methods of school instruction on the other.

Confining our attention to investigations of the children's choice of ideal characters, we find that the younger pupils select a person in their immediate environment—a relative or a member of their circle of acquaintances—whereas with increasing age there is a wider range of choice, historical characters, public men, etc., being selected. The younger children likewise express preference for material wealth, etc., while with older pupils ethical and æsthetic values preponderate. The elementary schools are, in comparison with higher grade schools, inferior in furnishing ideals, and the German schools are in this respect behind the English and American. In the reasons given for preferences a development can also be traced; the younger children apply to the preferred personalities indefinite predicates like good, etc., whereas special characteristics like brave, wise, benevolent appear in the accounts of older scholars. The choices of girls are more limited to characters in the immediate environment than is the case with boys, and biblical characters are more favoured with

girls. Secular history furnishes the greatest proportion of ideal characters, and far behind it come biblical history, poetry, and literature.

In directing attention to inhibition and suggestion lies the most valuable contribution of Experimental Psychology to the subject of the ethical development of the child. The most important, and at the same time the most harmful, of the various forms of inhibition are the specific emotional and volitional forms, which have for long remained unrecognised by educators. Meumann illustrates these from the experience of a boy whom he knew.[1] On his entrance to a new school his previous teacher, who had an antipathy to him, was tactless enough to introduce him to the new teacher with a drastic and false report. From that moment the boy, who so far had been above the average, did no good; not only did his intellectual efforts diminish from day to day, but his attention and conduct also deteriorated, and he became emotionally depressed. At the end of the school year he failed to obtain a remove, and the boy would have been ruined, had not his parents, who had faith in their child, withdrawn him. He was sent to another school and there met a teacher who showed confidence in him; from that moment the boy changed completely, gained excellent certificates, and left as one of the best pupils. His case is typical, in that a single definite volitional inhibition entered into the life of the child, extended to the entire inner nature, undermined his self-confidence, depressed his emotional life, and diminished all his efforts, intellectual as well as moral.

[1] Vol. i. p. 298.

If such a child is not saved through change of environment, or the opportune introduction of a sympathetic teacher, or if he has not the power to rise above the effects of the inhibition, his career may be ruined. Seizures by such inhibitions in the volitional life of the child occur extraordinarily often and are in a sense parallel to the physiological inhibitions which arise through the premature exertion of the physical powers.

Two forms of such inner inhibitions can be distinguished.[1] One arises in a special sphere and has a certain retro-active tendency, but it does not go beyond this sphere; the other begins either from a single incident, in a certain subject, or from a definite class of work, has an extensive tendency, and eventually affects the whole mental life of the child.

The former type is frequently exemplified in laboratory work.[2] A pupil may be required to memorise a series of twelve nonsense syllables and may get the impression that the task is beyond his powers; the result is that the number of repetitions required for learning increases immensely and sometimes no learning at all is effected. If the same pupil, on first learning, found the task easy of accomplishment and received the impression that his powers were adequate to the task, the number of repetitions required for learning the series would decrease rapidly and the learning of nonsense syllables would progressively improve. The effectiveness of such voli-

[1] *Cf.* Münsterberg, "Psychology and the Teacher," pp. 208–11.

[2] *Cf.* Myers, "Text-Book of Experimental Psychology," p. 163.

tional inhibitions is most easily observed in tests on immediate retention, when the method of gradual increases in the length of the series is employed; seven words may readily be retained by the subject without a mistake, whereas, when the series consists of eight words, only two or three are reproduced. The explanation is that the presentation of the series of eight words suddenly arouses the feeling that the series is too long, the attention is inhibited at a definite place in the series, and the subject forgets all, or almost all, that has been previously impressed on the mind. The inhibition thus works backwards and disturbs the impressions made under normal conditions.

The prolonged self-extending form of inhibition, although fundamentally the same phenomenon, acts in a somewhat different manner. It occurs, as a rule, in the efforts of a child in a special subject. The pupil may, through wrong treatment on the part of the parent or teacher, or the action of his fellow-pupils, suddenly become remiss and his efforts, mainly in a particular subject alone, fall off; the relations between the pupil and the teacher undergo a change, they lose confidence in each other, the pupil loses confidence in himself, and his work in all subjects suffers. The child can succumb completely to such volitional inhibitions and his whole life may thus be grievously affected.

All natures are not equally susceptible to these inhibitions, and when they appear they affect individuals differently. One type suffers only transitorily and overcomes them unaided; some are

affected for a time, while others may be injured permanently. Sensitive natures are especially susceptible to volitional inhibitions, as are also children with a tendency to emotional depression, or those whose self-confidence is weak, whose suggestibility is great, whose endowment is irregularly distributed over the school subjects. A similar susceptibility characterises those who are very ambitious, and individuals who are physically retarded or delicate.

In such cases experiment can render the greatest service by demonstrating the presence of volitional inhibitions. By experiment it is possible to determine quantitatively—for example, through memory tests—the simple intellectual efforts of an individual in whom the existence of inner inhibitions is suspected. These can be compared with his efforts in school work. It may be objected that the inhibition might extend to the experimental work, but when such tests are conducted in a laboratory an entirely new environment is provided and the work required of the pupil in the psychological experiment allows of his elementary powers being observed in a manner impossible with complicated school subjects. Such tests can also be employed as a means of overcoming the inner inhibitions. We can increase the child's self-confidence by adapting the tests to his powers and thus enable him to overcome the effects of his inhibition.

In close connection with volitional inhibition stands the phenomenon of the child's suggestibility. If the teacher can arouse inhibitions in the child he can contrariwise influence favourably, by suggestion, the

mental life. The positive significance of suggestion in education, as is evident from recent educational publications, is now coming to be recognised.[1]

Various tests have been employed to determine the suggestibility of individuals,[2] and the correlation between the results of some of the tests [3] would seem to indicate that suggestion is not to be regarded as a faculty, but that there are various forms of suggestion just as there are different forms of attention or of memory. Leading questions can be put in tests on testimony, and the susceptibility of the children to the influence of the experimenter thereby determined. The results of such tests indicate that suggestibility decreases slowly with age; the power of withstanding suggestive influence is at seven years of age half that at fifteen. Girls are more suggestible than boys, and the course of susceptibility to suggestion is, with the two sexes, an irregular one.

The common characteristics and actions of persons are more readily accepted by suggestion than those occurring less frequently, but the size of objects suggested has no influence in their acceptability; the position and colour of objects which do not exist in the test picture are even stated with definiteness by some children. The degree of suggestibility also varies, according to intelligence and temperament,

[1] *Cf.* Keatinge, "Suggestion in Teaching," and Adams, "Exposition and Illustration," ch. v.

[2] See, for example, Whipple, "Manual," pp. 299 and 404 *et seq.*

[3] Scott, "Personal Differences in Suggestibility," *Psychological Review*, 1910.

the less intelligent children, and also those of sanguine nature, being highly suggestible.

To strengthen the child's power to withstand unfavourable suggestions is one of the main requirements of education, and the best means of attaining this is to increase the child's self-confidence. It is important that every teacher should recognise what a powerful instrument for influencing his pupil he possesses in suggestion, and how this can be applied in a good as well as an evil way.

For questioning in instruction it is significant to note that a question has always a certain secondary suggestive effect. Some persons may have their views influenced as readily by questions as by direct argument, and this suggestive force in the interrogatory form of a statement must necessarily be much greater in the case of children.

The importance of the will, as one of the fundamental conditions of the intellectual efforts of the child, can readily be inferred from the foregoing, and on these grounds Meumann advocates the formal disciplining of the will, as against the Herbartian contention that the main factor in determining ethical development is the choice of the right material in instruction.

The above consideration of the æsthetic and ethical culture of the child will make it evident that we are at present but at the beginning of the study of these subjects. The importance of further experiment, more especially in regard to the ethical development, is forced upon every one who studies the problem of the ethical education of

children. Before we can say what instruction and training in this sphere the child should receive, and how it should be imparted, we must know more exactly than we do the ethical endowment of the child at the various stages of his career; and from this all our instruction and training must proceed.

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CHAPTER X

INDIVIDUAL DIFFERENCES

IN the early stages of the development of experimental psychology, when the main object of the study was to establish certain general laws, the individual variations which were disclosed in investigations were regarded by experimenters as disturbing factors which they would fain ignore if they could. Such individual differences have nevertheless come to be studied for their own sake, and this consideration now constitutes a special department of psychology. The new movement began only in the last decade of the nineteenth century; it has now a literature of its own,[1] and is international in character.

The "differential psychology," as Stern denominates it, adopts the categories and methods of procedure of general psychology, but it extends these and reforms them according to its own requirements. It investigates the formal aspects of variations, for example, the range of variation, the question of concomitant variation, the correlation of variations, and

[1] *Cf.* Stern, W., "Differentielle Psychologie." The bibliography in this work contains over 1,500 items.

the substitution and compensation of differences. It seeks to explain uniformities in variations and to determine which variations are dependent on inner causes (inheritance, etc.) and which on outward circumstances.

The differences disclosed by investigation are either quantitative, giving rise to differences in grade of mental power, or qualitative, giving rise to "types" of difference and endowment. The exact logical and methodological formulation of this concept of "type" is one of the most urgent problems of the science.[1] On the basis of such differences we likewise classify individuals as normal or abnormal. The new science also attempts to explain the individual as a unity and totality, whereas general psychology tends only to explain special characteristics.

In education an alternation similar to that experienced by psychology can be traced. The individual differences of pupils were for long ignored; now the demand is to individualise instruction, but opinion is not yet unanimous as to whether in education the individual differences should be reinforced or overcome.[2] It will, however, be generally agreed that before the problem can be solved we must determine the extent of such differences and their cause—that is, whether they are due to natural endowment or training; and this is the task which Experimental Education has set itself.

[1] Stern, Differentielle Psychologie, p. 162.

[2] *Cf.* Thorndike, "Educational Psychology," 2nd ed., p. 18, and Münsterberg, "Psychology and the Teacher," p. 170.

Teachers who profess to study the individuality of their pupils must now do so scientifically. To escape the labour of studying psychology, which, it was assumed, could only provide general laws, some teachers have been in the habit of maintaining that they studied the individual pupils; the new differential psychology, with its scientific treatment of individual differences, has, however, made untenable this lazy fallacy and demonstrated that a sentimental interest in individual pupils is not a substitute for a scientific study of their differences.

Practically every psychological investigation has revealed individual differences; consequently all the fundamental differences have been enumerated and definitely measured by the earliest workers in this field. But they were merely enumerated, their relation one to another being ignored; and many were regarded as fundamental which were in no sense elementary.

Attention has recently been centred mainly on the theoretical aspects of the subject of individual differences, and for consideration of such questions the reader is referred to Thorndike's "Educational Psychology," as this branch of the subject is there treated at considerable length.[1]

The fundamental differences can, according to Meumann, be classified according as they appear in the intellectual, the emotional, or the volitional life. In the first class, the intellectual, are included the elementary differences in the sensori-motor groundwork of the mental life; the relative times of the various psychical processes; the formal aspects of

[1] Ch. viii. to xi.

the sensory processes; the individual differences in observation, memory, association, and reproduction, in assimilation and apperception, in attention, attunement, adaptation, practice, fatigue, habituation. These all require investigation, and when this has been accomplished there still remains the main task of the psychology of individual differences, which is of the utmost practical importance. This task is the investigation of the inner relation of these differences in one and the same individual, and of the dependence of one characteristic upon another.

Kraepelin was the first to investigate individual differences experimentally. The behaviour of subjects in psychological experiments led him to suppose that there were certain fundamental personal characteristics which could be measured, and that, by means of such measurements or quantitative determination, an insight into the degree of variability of single individuals could be obtained.

The fundamental differences enumerated by Kraepelin were as follows:—

(i.) Those disclosed in reaction time tests, for example, in the rate of apprehension of sense-stimuli, of association and reproduction of images, and in expression of volitional processes. This he termed "the determination of the capacity for mental work."

(ii.) Improvability or capacity for improvement with practice, or ability for forming habits. Mental ability improves with practice, but the amount and manner of improvement varies in individuals.[1]

[1] *Cf.* Myers, "Introduction to Experimental Psychology," pp. 115–17.

(iii.) Retentiveness of improvement—also called "general memory." Improvement due to practice in an acquired dexterity may be more readily lost by some individuals than by others.[1]

(iv.) In opposition to this so-called general memory Kraepelin distinguishes the capacity for effort of the special memories; the greater the number of impressions, for example, colours, tones, etc., retained after a definite time, the greater the capacity of the special memory.

(v.) Incitation (German "Anregung"), closely connected with which is Adaptation ("Anpassung"), is the term used to denote the process of getting under weigh or "warming up" to a piece of work. A certain time elapses before we attain our maximal efficiency, and this period of time is the measure of the degree of incitation. Incitation always takes place when a task is undertaken. Adaptation, which consists mainly in the overcoming of distractions, is exhibited when a new form of work is taken up, or when a task is renewed after a long interruption.

(vi.) Fatiguability, determined by the decrease in efficiency after prolonged effort.

(vii.) Recuperative capacity, which stands in definite relation to Fatiguability, is determined and measured through the increase in efficiency in a definite time after fatiguing work. The more quickly the maximal effort is attained after a rest pause, the greater is the recuperative capacity.

(viii.) Soundness of sleep, a characteristic which has a physical rather than a psychical value, is closely connected with recuperative power, since sleep is the

most important means of recuperation. It is measured by the strength of the stimulus, which, at various periods of sleep, is just sufficient to awaken the subject.

(ix.) The ease with which distraction occurs, its opposite being the power of withstanding distracting influences on beginning work.

(x.) Habituation, which is measured by the effect of prolonged disturbing influences on the work of an individual.

The defects of Kraepelin's enumeration are at once evident. There is no principle of division upon which the classification is made, and no relation is indicated amongst the ten characteristics enumerated; but the investigation is valuable as an indication of the lines upon which later work on the qualitative determination of individual differences may proceed.

Other investigations have disclosed differences in sensory acuity and sensory discrimination; to these again may have to be added differences in the constancy of these characteristics, for with some individuals greater variations in the threshold of intensity, and in the least perceptible differences, occur than with others.

Measurement of the rates of mental processes discloses a series of individual differences, valuable in themselves and also as indicating qualitative differences. These include the rate of adaptation of attention, the rapidity with which the effect of practice or recuperation sets in or disappears, the rate of release of volitional impulses, of reproduction of

images, and, in general, of all mental efforts which take varied times. Stern has denominated the differences in these time relations, especially with respect to the rate of tapping, as the "psychical *tempo*";[1] but there doubtless requires to be distinguished from the general *tempo* the *tempo* of the special mental efforts of an individual.

Individual differences in the susceptibility to emotional effects occur and can sometimes even be measured. In æsthetic tests it is found that to judge forms and colours as pleasing or displeasing, some individuals require stronger æsthetic stimulation than others. In addition to differences in objective stimuli there are also differences in "empathy," that is, in the feeling induced in the subject by the suggestions of strain, movement, or rest in an object.[2] Some persons are found in tests to react readily to pleasing and to displeasing effects in colours, who remain indifferent to tones, and *vice versa*; there are others who make an emotional response to theoretical considerations, judgments of truth or falsity, more easily than they respond to purely æsthetic effects; while others are most sensitive to utilitarian aspects.

Some of Kraepelin's fundamental properties have reference to differences in the physical bases of the mental life, especially in nervous energy. Properties like fatigue, habituation, etc., must be connected with the expenditure of nervous energy. Individuals expend energy differently in different periods of

[1] Differentielle Psychologie, p. 85.

[2] See Myers, "Text-Book of Experimental Psychology," p. 331.

work. We have already seen[1] that there are variations in capacity for work throughout the year; there is likewise a diurnal rhythm in mental efficiency. According to the investigations of the Kraepelin school, there can be distinguished a day and a night curve in the expenditure of energy. In all tasks, whether of long or short duration, there is a periodic rise and fall in the course of energy, and also variations in this rhythm. Individuals who live under similar conditions exhibit in common the following diurnal rhythm. In the morning, shortly after sleep, energy is rather low; in the forenoon it attains its first maximum, and about mid-day it sinks to its first minimum; in the course of the afternoon, about 5 p.m., a second maximum appears, which towards evening gives place to a second minimum, due to the increasing fatigue. The course of muscular energy differs from that of mental energy. We have already mentioned such a difference in the variations throughout the year—in summer motor energy increases and mental decreases.[2] Likewise, according to Meumann's measurements of fatigue, there is a rapid increase in motor energy in the afternoon, while the capacity for mental effort is still low. Other results indicate that in the morning the mental efficiency increases, up to mid-day; there is a decrease to 5 p.m., followed by an increase to 9 p.m., and thereafter a decrease till midnight. The divergent results may be due to the expenditure of energy differing between individuals working continuously and others working with rest pauses, or between children and adults. With a dili-

[1] Chapter III., above. [2] *Ibid.*

gent child a high degree of fatigue sets in even before midday, and with adults, too, energy is at a minimum between 12 and 1 p.m. The general course of energy seems to be influenced by the expenditure of energy occasioned by the work and mode of life of the individual. The former accounts for the constantly recurring phenomenon of a diminution in the capacity for work from 1 to 5 p.m.; the latter appears to induce the relative maximum that occurs towards mid-day.[1]

The most important individual variations from these daily courses are those exhibited by the morning and by the evening workers.[2] With the former the maximum of the day's work is attained during the forenoon; with the latter in the evening. The individual differences in the night curve follow the distribution of the soundness of sleep. The morning worker begins right away to sleep soundly, and towards morning his sleep becomes lighter; with the evening worker the reverse is the case.[3]

In short periods of work there is at the outset a relative minimum in the work curve occasioned by "incitation," or the "warming-up" process, and, towards the close, a minimum due to increasing

[1] *Cf.* Whipple's "Manual," p. 96; Offner's "Mental Fatigue," English trans., p. 72; Claparède, "Psychology of the Child and Experimental Pedagogy," English trans., pp. 256–57.

[2] Stern, "Differentielle Psychologie," p. 191.

[3] *Cf.* Münsterberg, "Psychology and the Teacher," pp. 225–26; "Claparède," pp. 258–59.

fatigue. Other differences arise from the dislocation of such factors.

Of more value for the individual life are the differences in attention; but as these operate mainly on the intellectual side, they will be treated in connection with the doctrine of endowment. Less known are the fundamental differences in volitional life, in its motor bases and its moral qualities, and many individual differences attributed to the intellect should probably be assigned to the will. For example, in psychological tests some individuals give indecisive judgments, others are very definite. Stern has distinguished three individual characteristics in judgments—decisiveness, reliability, and suggestibility. Meumann contends that these are volitional rather than intellectual characteristics.

The form of innervation of our movements and the simple and compound motor reactions to sense-impressions disclose to us thoroughgoing individual differences. One of the most important is that termed attunement.[1] When, for instance, we proceed to lift a body of a given size, through continuous practice we learn to put forth just sufficient exertion for the task. This is readily recognised when we raise an empty box believing it to be full, and it is a determining factor in certain illusions. Two separate types of motor attunement have been found, termed respectively the strong and the weak—the former a characteristic mainly of males, the latter of females.

[1] *Cf.* Myers, "Text-Book of Experimental Psychology," pp. 221–27.

In reaction tests when a stimulus is given and a given movement has to be executed, individual differences have been exposed, and types have been based on them.[1] One type of subject, termed the "motor" type, attends to the movement to be executed rather than to the stimulus; the other, the "sensory" type, directs the attention to the expected stimulus, and in this case the reaction is slower. The question has been raised whether these exhaust the typical modes of reacting, or whether there may be others. Flournoy has maintained that there are four reaction types, distinguishing, in addition to the "motor" and "sensory," the "central" and the "indifferent." The central has the shortest reaction time, the subject's attention being concentrated on the reaction as a whole—from stimulus to movement; with the indifferent type the direction of attention has no definite effect on the rate of reaction. Stern has distinguished between a "subjective" and an "objective" type. The former takes up an active attitude to everything that he encounters. His own action forms the central point of things, and his environment is only of significance in so far as it participates in this. The latter type allows outer stimuli to affect him passively; he regards them theoretically. His attention is sensorially directed and his attitude is contemplative. For the subjective type the stimulus is merely the occasion of the response, for the objective type it is the cause of the reaction.[2] It has been disputed whether such

[1] Stern, "Differentielle Psychologie," p. 214.

[2] *Ibid.*, p. 215.

differences are fundamental and due to endowment, or merely the result of training. Meumann supports the view that they are fundamental, and maintains that the doctrine of types is valid here. He suggests the following classification: One type, he says, reacts from the outset much more quickly than the other, displays strong motor tension, and directs the attention solely on the organ to be moved —this is the impulsive type. The second type is the intellectual or reflective type—those who await the stimulus calmly, try to apprehend it clearly, and take longer to react.

Differences in attunement may also be disclosed in association tests. Those subjects who reply quickly, but give little introspective detail, form one type; the other type take longer but give a fuller account of how they arrive at the response.[1]

These are but illustrations of the main individual differences thus far investigated. The unsystematic nature of the results will be apparent. Some of the differences enumerated may not be elementary, some may be relative, as the synthetic treatment yet to be undertaken may show. If, however, we push too far the doctrine of individual differences in a given subject of study, we make a science of that subject impossible; we must consequently turn to the doctrine of endowment to learn whether amongst these differences general types can be discovered.

[1] *Cf. British Journal of Psychology*, vol. iii. pp. 358–59.

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CHAPTER XI

THE DOCTRINE OF ENDOWMENT

THE metaphysical question of the relation of inheritance and environment appears in educational science as the question of the relation between natural endowment, or innate ability, and educative influences. The educator no longer believes that the mind of the pupil is a *tabula rasa*, and that he can make of the pupil what he will; nor, on the other hand, that the pupil's progress is the result of the spontaneous evolution of innate capacities, and that it is quite unaffected by the teacher's efforts. But exactly how much is to be attributed to native ability, and how much to the influences of education, is the question which Experimental Education has set itself to determine. The doctrine of endowment also seeks to discover whether defects in endowment can be overcome by special training, and what are the limits set by innate conditions to the work of education.

Certain questions of a more theoretical nature also arise—for example, in regard to the relation between mental traits, whether some aspects of endowment are related inversely, or whether the relation between others is that of mutual dependence or dependence

on some general fundamental characteristic. The belief in mental compensations or antagonisms is a popular one; for example, it is thought that the person who is blind is endowed congenitally with, or acquires, special sensitivity in regard to auditory experiences, and that the individual endowed with great imagination is useless at abstract work. The belief in the mutual dependence of mental characteristics, although apparently incompatible with the belief in mental compensations, is no less general: it takes the form of maintaining that there is some fundamental capacity of general intelligence which enables an individual who is possessed of it to apply it successfully to whatever mental sphere he desires.

A question which is both of theoretical interest and of practical importance is the question of mental types; whether individuals can be classified into types, or whether individual differences are not so pronounced as to admit of such a classification. Such questions as we have enumerated can only be satisfactorily solved by systematically controlled tests.

The standard usually applied by teachers and others to estimate a pupil's endowment is the school work of the pupil. The unsatisfactoriness of such a standard is evident in the limitations and reservations which commonly accompany the statement of such a principle—for example, that an intelligent pupil, owing to bad health, unfavourable home influences, or other causes, may not excel in school work, whereas a less intelligent pupil by great zeal may stand well in class. The fact that the teacher's esti-

mate of a pupil's ability is frequently falsified in later life also indicates that not all the factors necessary to estimate endowment fully have been taken into consideration.

The general methods whereby we distinguish natural ability from the effects of educational influences on endowment are simple. The effect of practice is the test usually applied. If one of two individuals takes longer to learn a certain form of work than another, we conclude that the latter is the better endowed for this activity; if after great effort no progress is made, we assume that there is no natural aptitude for the subject. The absolute amount of work accomplished, arrived at by comparing the work of an individual with the average performance of mankind, either generally or in some particular sphere, may also be taken as the measure of congenital endowment. Endowment can likewise be determined by the degree of spontaneity shown by an individual. If a child begins at an early age to sing or to take pleasure in music, we naturally regard him as highly talented; the environment of the child must, however, be taken into consideration in estimating the degree of spontaneity.

The more exact methods that have been applied in determining endowment are of two classes—the indirect or physical, and the direct or psychological.

The indirect or physical methods seek to determine the endowment of the child mainly by anthropological tests—for example, by determination of the cephalic index. The defect of these methods is that the inference from the physical nature of the child to

his mental capacity is always uncertain. The only result of value so far obtained is that the better endowed children display on the average the better bodily development. It would nevertheless be "a fallacy of division" to apply this conclusion to any one individual. The anthropometric investigations have, however, positive value, as they furnish, easily and quickly, definite measurements of the child; these supplement the psychological measurements and enable us to learn the physical condition of the intelligent and of the unintelligent child, and how the physical and psychical characteristics are related.

The direct or psychological methods of determining endowment fall into two groups. The first, the "Test-Methods," lead to a definite quantitative determination of the grade of endowment. The second group of methods concerns itself mainly with a comprehensive investigation of the individual's whole mental endowment, and aims chiefly at a qualitative analysis of endowment.

The Test-Methods are divided into two classes. Either relatively disconnected tests are applied—for example, reaction time, motor skill, rate of tapping, memory, association, tactual localisation, sensory discrimination tests, etc.; or series of graded tests arranged in order of difficulty are so chosen that the grade of general intelligence for various ages may be thereby exactly determined. To the former belong most of the older test-methods; to the latter Binet's scale.[1]

[1] The simplest introduction to these methods will be found in Myers, C. S., "Introduction to Experimental Psychology," ch. vi., vii.— "Mental Tests and their Uses."

The isolated test-methods have for a time been held in discredit, but at present they are being rehabilitated. It was found in investigations on sensory discrimination that generally the most intelligent subjects had the lowest thresholds, and it was concluded therefrom that one had only to measure, for example, the sensitivity to differences in pitch or the spatial threshold, to determine the degree of intelligence of an individual. Memory tests, association tests, etc., were also thought to give results indicative of the degree of intelligence; but extended applications of these methods usually resulted in contradictory conclusions. An exceptionally good memory is often found to coexist with very low intelligence, and in reaction-time tests rapidity may frequently be accounted for by the fact that the responses made are of no value qualitatively. As a consequence, the value of the isolated test-methods came to be discounted; but by grading the tests in order of value and by constructing new tests suitable for the higher intellectual functions, Burt[1] has shown that this method of isolated tests provides a means of solving the question of the existence and measurement of general intelligence. Isolated tests are also of value in providing quantitative determinations of the special mental powers, and by using in

[1] "Experimental Tests of General Intelligence," *British Journal of Psychology*, vol. iii. pp. 94–177.

"The Experimental Study of General Intelligence," *Child-Study*, vol. iv. pp. 33–45, pp. 92–101.

"Experimental Tests of Higher Mental Processes and their Relation to General Intelligence," *Journal of Experimental Pedagogy*, vol. i. pp. 93–117.

combination typical tests from the various spheres—for example, the sensory, attention, association, thinking or reasoning—we may be able to secure "mental profiles"[1] of the individuals tested.

No subject has in recent times aroused such widespread interest in educational circles as Binet's scale of intelligence.[2] Its practical value is apparent: by its use we can determine easily whether a child is behind his age in intelligence, and it enables us to say whether a child should be regarded as mentally deficient or not. Its simplicity is likewise a recommendation. No costly instruments are necessary for its application, and the instructions which it is necessary to follow are expressed in popular terms. In this simplicity may, nevertheless, lie the weakness of the scale. It may come to be applied by untrained individuals, ignorant of the conditions of exact experiment; and the results obtained by such observers will not only be valueless, but positively misleading. Alterations in the scale will in practice doubtless be found necessary, and the scale may even in time be superseded by a scale the tests of which are more psychological in nature and which enable us to know more definitely the exact functions tested by the various questions. In fact, the combination of selected isolated tests mentioned above and Binet's scale may ultimately develop into one new scale.

Binet's tests include the recognition of known and unknown things, naming of objects and pictures, comparison of lines, comparison of weights, memory

[1] *Cf. Journal of Experimental Pedagogy*, vol. i. pp. 211–14.
[2] For literature see end of chapter.

tests, combination of words into a sentence, definitions of abstract terms. The requirements, for example, for pupils of seven years of age include showing the right hand and the left ear; description of a picture; performance of three simultaneous commissions, for example, to put a key on a chair, shut the door, bring a box; counting thirteen halfpennies; naming four colours. The tests for ten-year-old pupils are—to arrange in order five boxes of identical shape and colour but differing in weight; to copy figures from memory, to criticise sentences containing absurdities, to reply to difficult questions, to put three words into each of two sentences.[1] Such tests are examples of what Myers regards as "tests of production" rather than "psychological" tests. "They determine,"[2] he says, "how *much* an individual can work, how *much* he knows—not *how* he works, *how* he knows. A man's productivity, of course, is what we want to ascertain in every-day life. We do not care how a man comes to use or to acquire his powers; we are content with a mere dynamometric or other record of his prowess. But this aspect cannot properly be called the psychological aspect."

From the tests which not only determine endowment quantitatively, but also attempt comprehensive psychological analysis, Meumann selects four groups as of most value: (1) the methods of analysis of sense-perception, of which the tachistoscopic are the

[1] *Cf.* "An English Version of Binet's Tests," by Katherine L. Johnston, *Training College Record*, vol. i. No. 5; also *Journal of Experimental Pedagogy*, vol. i. pp. 148–51.

[2] *British Medical Journal*, No. 2613, pp. 196–97.

most useful; (2) the association and reproduction methods, especially the procedure with controlled or constrained associations; (3) testimony investigations; (4) completion methods. These various methods disclose to us groups of mental processes which permeate the mental life and in which deep-seated intellectual differences in individuals lie. Each of the methods can be applied in various forms.

In the foregoing chapters [1] these methods, with the exception of the completion-methods, have already been mentioned. The completion-method or combination-method was devised by Ebbinghaus, who regarded it as a test of intelligence and characterised it as a simple, easily applied device for testing those intellectual activities that are fundamentally important and significant both in the school and in life. [2] The test consists in filling out a text from which words, parts of words, or parts of sentences have been elided. The main objection is that it may well become a test of vocabulary rather than of intelligence. Binet's test, in which a sentence incorporating three given terms has to be constructed, may be regarded as a form of completion-test and is free from the above objection. Schematic drawings, which the pupil is required to explain and complete, may also be used as a form of completion-test.

In considering the results available, the most satisfactory method is to begin with the physical charac-

[1] See especially Chapters IV., V.; VIII.; VI.

[2] For examples of test see Whipple, "Manual of Mental and Physical Tests," pp. 445–57.

teristics of the intelligent and the unintelligent child. A knowledge of the connection between the physical and the psychical is indispensable for the practical handling of the child, and the determination of the limits between the normal and the mentally deficient child is partly dependent on the presence of physical characteristics. In respect to abnormal children, we have fairly definite results at our disposal. The weak-minded child is, as a rule, also physically deficient, and the extent to which this occurs is often not fully realised by teachers who have not such children to deal with.

The body of the abnormal child, often entirely different from that of the normal child, is less in stature and in weight, has less developed muscles, flat chest, and often abnormal skull formation, and the cephalic index is usually under the normal. Not unusually the skull is macrocephalic or, with idiots, microcephalic. A tendency to aimless movements of the ocular muscles, of the hands and the feet, even of the whole trunk, accompanies every attempt at strenuous concentration on mental work.[1] The psychical symptoms of the feeble-minded child include retardation in learning to speak; defective command of language, of writing, and of other technical dexterities; extremely limited power of attention in respect to intensity, duration of concentration, and consequently an unstable disposition; either haste or transitoriness or extreme slowness in perception, speaking, and thinking; exaggerated or deficient self-confidence; great emotional abnor-

[1] *Cf.* Warner, "The Study of Children," ch. vi.

malities, numerous moral weaknesses and perverse tendencies, combined with a lack of sympathy for fellow-creatures and for animals.

Various degrees of feeble-mindedness have been distinguished. There are two main types—the backward or stupid but not abnormal, and the subnormal. The first class need not be physically deformed, but can be quite sound and strong physically, and may even be exceptionally developed muscularly. This class can accordingly be further divided into children who are physically and mentally backward, and those who are merely mentally backward but physically normal or above the average. Of the subnormal two quite distinct types exist. One type betrays itself but little in childhood, only becoming definitely apparent in later life; it has been characterised as the intelligent feeble-minded, and an individual of this type may be distinguished in all forms of intellectual work, but lack judgment in the affairs of practical life. The other type is quite different and comprises two classes—the imbeciles and the idiots.[1]

Above the whole group of subnormal children stands the normal child. This class at each age comprises various grades and displays numerous qualitative variations, on the basis of which types are arranged. Under normal children we must distinguish the retarded, that is, those who are behind the average for their age but who are not abnormal. The supernormal or precocious children who are in advance of their years, the extreme example of which is the prodigy, demand separate classifi-

[1] See Thorndike, E. L., "Educational Psychology," ch. xi.

cation. On practical grounds the backward or retarded child presents the greatest difficulties and gives rise to many problems, for example, segregation, etc.,[1] but attention is now also being directed to the treatment of the supernormal or "forward" child.[2]

The results obtained by the application of the isolated test methods are of doubtful value. Pitch discrimination is regarded by some as an index of general intelligence. Meumann regards attention, best exemplified in mechanical learning, as having, for the intellectual side of the mental life, approximately the value of a fundamental function. Burt,[3] on the other hand, regards the irregular dotting test, a test specially devised to secure voluntary attention, as a better index of general intelligence than any sensory or memory test. From the results of a later investigation he indicates that reasoning tests seem to give correlations with intelligence which are as much superior to attention tests as these are to the sensori-motor tests.[4] From his extensive investigations Burt concludes[5]: "By means of some half-dozen brief experiments we are

[1] For various methods of treatment see *Journal of Educational Psychology*, vol. i. pp. 132–44.

[2] See, for example, Stern, "The Supernormal Child," *Journal of Educational Psychology*, vol. ii. pp. 143–48, and pp. 181–90, and "A Plea for the Forward Child," by Anita U. Boggs, *The Child*, vol. ii. No. 1.

[3] "Experimental Tests of General Intelligence," *British Journal of Psychology*, vol. iii. pp. 94–177.

[4] *Child-Study*, vol. iv. p. 93.

[5] *Ibid.*, p. 94.

able independently to arrange a group of strange boys in an order of intelligence which shall be decidedly more accurate than the order given by scholastic examinations, and probably more accurate than the order given by the master, based on his personal intercourse with them during two or three years, and formulated by him with unusual labour, conscientiousness, and care."

In regard to the existence of a general fundamental function, termed general intelligence, Burt concludes from his investigations that there is a general function—a greatest common measure—permeating, to a greater or a less extent, the various special functions measured by his tests; that the measurements obtained are measurements, more or less indirect, of a single capacity, and not determined purely by different capacities in different cases; and that the notion of an all-round mental efficiency applicable in many directions is a legitimate conception. It may be defined, he states, as an all-round innate mental efficiency and can be most readily measured by tests of the higher and more complex levels of mental activity. He admits that his conclusions are still largely hypothetical, but claims that they form a hypothesis which is founded upon experiment, and that by experiment alone can they be firmly established, fully extended, or finally overthrown.

Systematic application of the Binet scale, published in 1908, was made by Miss Katherine L. Johnston at Sheffield with 218 girls of six to sixteen years of age. The results[1] show that the tests for

[1] *Journal of Experimental Pedagogy*, vol. i. pp. 24–31.

the older pupils were too difficult, the tests for the age of nine being most difficult of all. An American investigation based on the 1908 scale likewise discloses the fact that the scale is far too easy at the lower end, while at the upper end it is too difficult.[1] That a revision of the tests seemed to the author to be necessary is evident from the fact that a revised scale was published in 1911, and this makes it unprofitable to discuss further the results obtained by the older scale.

Passing to the qualitative determination of endowment, we find the question as to the existence of "types" arising. Meumann accepts the doctrine of types, and attaches considerable importance to it, whereas Thorndike denies that it is possible to establish the existence of types, maintaining that the differences reported as "typical" are merely extremes of the same trait.[2] The question is still undecided, but the doctrine of types is accepted in practice, for teachers do not hesitate to classify certain pupils as mentally deficient, although theoretically they may admit that between the mentally deficient and the normal pupil there are grades of intelligence which make the connection between the two continuous. As pupils are now generally taught in classes, the tendency will be to treat them as belonging to certain types, whether the doctrine is established theoretically or not.

As Thorndike's view is available in his "Educational Psychology," we shall here present the doctrine of types mainly from Meumann's standpoint.

[1] *Journal of Educational Psychology*, vol. iii. p. 70.
[2] "Educational Psychology," ch. x.

Sense-perception can give rise to individual variations by reason of the manner in which the sensory apparatus of the various senses functions. This determines whether the sensations have the qualitative variety and the grades of intensity which we regard as characteristic of the normal individual. Defects in the sensory apparatus cause psychical anomalies like colour blindness, etc., but even in the absence of these anomalies individual differences in sensory acuity and sensory discrimination occur. Such differences are, however, relatively insignificant in comparison with the greater variations in the higher psychical functions. Thus, in cases like Laura Bridgmann and Helen Keller, serious deficiency in sensory powers does not, to any great extent, affect the higher endowment.

The spatial and temporal aspects of perception present fewer individual differences of endowment than does sensation, although the ability to estimate time discloses great individual differences, and in respect to rhythm the differences are fundamental and typical. In estimating the length of time which a certain movement takes, some individuals depend on their consciousness of the time taken, while others depend on the extent of space passed over; on these grounds psychologists distinguish a temporal from a spatial type of apprehension. If, again, an arm-movement is carried out with the eyes open, and then repeated with the eyes closed, it is found that one subject relies on the space passed over, another on the time taken, and a third on the impression of the first and last positions

of the arm. Stern accordingly maintains that a "material" type of apprehension, depending on the sensational content, and a "formal" type, depending on the spatial and temporal relations, can be distinguished, and that these types stand in close relation to the concrete and the abstract imagery types.[1]

Great individual differences of endowment appear in the sense-memories. It is a well-known fact that one individual can recall tunes better than colours and forms, and that another can remember faces better than names, whilst a third may have a good memory for numbers but no memory for poetry. Some individuals have no "bump of locality," whereas others may tend to confuse the temporal relations of events. Some students may be able to impress on their minds easily the subject-matter of a lecture but be unable to reproduce the words, whereas others can easily give the exact words of the lecturer. These preferences may be accounted for by "interest," but if we seek to analyse such interests we find that they are in many cases based on congenital dispositions for a certain activity or for retaining a certain kind of material.[2] As these sense-memories to a large extent determine the imagery types, we need not deal with them here, as the latter will be fully dealt with below.

In the apperceptive aspect of perception, Experimental Psychology has disclosed in the partial processes—in attention, in apperceptive imagery, and

[1] *Cf.* Thorndike, "Educational Psychology," pp. 201–203.

[2] Offner, M., "Das Gedächtnis," p. 210–17.

in the reproductive processes involved—numerous individual differences which determine endowment differences.

Binet found that descriptions of an object or picture by different individuals presented certain characteristic differences: on the basis of such differences he arranged his subjects into four classes or types—the descriptive, who merely enumerate what they see; the observational, who describe movements and relations of figures in the picture they are describing; the emotional, who attribute emotions to individuals in a scene; and the erudite, who relate all they know about an object.[1] In this classification the observational stages, already mentioned in connection with the psychology of testimony,[2] appear to be reproduced, the purely descriptive type in Binet's classification corresponding with the substance stage of Stern, and the observational type with the action stage. Stern would reduce Binet's four types to two general types, the "objective" and the "subjective." Binet's types cannot, indeed, be regarded as elementary; they are, according to Meumann, determined partly by interest, which is conditioned by practice and habit, and partly by individual differences in the properties of attention. Interest may be directed to the actual object, to its theoretical aspect, or to its emotional value—æsthetic, ethical, or practical; the first-mentioned trend of attention probably corresponds to the

[1] *Cf.* Whipple, "Manual of Mental and Physical Tests," pp. 286–92.

[2] See Chapter VI., above.

analytic, the other two to the synthetic types of attention. Binet's types may consequently be brought under these categories, and Stern's categories of observation may be added as a standard for the development of apprehension.

The imagery types, on account of their pedagogical significance, have received more attention than any other aspect of the endowment problem. Imagery types arise from the fact that individuals differ from one another in the sensuous content of their images. There are two forms of imagery used in thinking—concrete object imagery, used mainly when we recall experiences which have previously occurred, or when we allow our imagination to run free; and verbal imagery, constituting the silent speaking which usually accompanies thinking in the narrower sense, that is, judging, reflecting, etc. Thinking without imagery is likewise possible.[1] Each of these two forms of imagery may be variously constituted with different individuals; hence the imagery types.

The first type is the visual, deriving its material from visual perception; the second, the auditory, dependent on hearing; the third, the motor (kinæsthetic or tactual), constituted by experiences of touch or movement. The last alone is not yet adequately determined. We may regard these as pure types, since an individual's imagery may possibly consist exclusively of visual, auditory, or motor elements. Gustatory and olfactory types may also exist but are not common. Various combinations of these are possible and give rise to mixed types.

[1] *Cf.* Watt, "The Economy and Training of Memory," p. 99.

In attempting to determine the predominance of a type in any individual, the nature of the reproduced object or process must be considered, because imagery tends to adapt itself in a certain degree to the nature of the object recalled; thus in recalling a procession visual imagery may be dominant with an individual who recalls a melody by auditory imagery. The predominance of one form of imagery—for instance, visual—may be the result merely of habit and not of an innate disposition to visualise. When the dominance of one type of imagery arises from congenital tendency, the other forms of imagery may exist only feebly and an artificial change of imagery type, though difficult, is possible; or the other forms may be entirely absent, constituting a psychical defect for which, so far as our present knowledge extends, there is no compensation.

The two main forms of imagery—the concrete and the verbal—are in the same individual usually quite differently constituted. The difference in the material of the images corresponds to a difference of function. As words are acquired by an acoustic-motor process, in verbal imagery, auditory and motor elements preponderate over other sense elements. Consequently one or, at most, two forms of sensory elements are usually employed in the construction of verbal imagery, whereas concrete imagery is composed of sensory elements derived from other spheres. Thus, most individuals are visualisers when they do not think in words; when thinking in words they belong to the acoustic-motor type.

Within the concrete visual type there exist qualitative differences, some individuals imaging colours best, others forms. These differences may be intensified by training; but there are individuals strongly endowed in one such aspect, even when this is not due to training. In the concrete auditory, the tactual-motor, the olfactory, and the gustatory forms of imagery differences and extremes are found, similar to those existing in the visual sphere.

Of more importance pedagogically, and more exactly investigated psychologically, are the typical differences displayed in thinking in words. The following pure verbal imagery types can be distinguished: the auditory, who thinks in words heard, consequently in the imaged sounds of spoken words; the visual in the visual forms of printed or written words; the motor type in experiences of previous vocal movements, including incipient movements of the larynx, tongue, or lips. In addition to these pure types it has been maintained that there are indifferent or mixed types, in which there is no predominance of any one order of sense elements. Whether all the possible types actually exist can only be determined by experiment: it is doubtful whether auditory-visual imagery without the presence of motor factors, or whether a visual-motor type, exists.

There are three classes of methods for determining imagery types, namely, memory methods, association or reproduction methods, and the Kraepelin methods.

Of the memory methods, the simplest is to obtain

the subject's introspection as to the process of retention. Various forms of distraction—for example, the beat of a metronome—can also be introduced in the memorising tests and the effects noted. The method of prompting or of aids may likewise be employed as, for example, getting the subject to learn rhythmically, which assists the auditory and motor type; or grouping the material spatially, which assists the visualiser. Netschajeff's and Lobsien's tests[1] may also be applied for this purpose.

The reproduction methods or association tests have already been discussed,[2] and the necessary variations require but brief enumeration. The stimulus word may be either spoken or presented visually. Sounds, colours, etc., may be substituted for words as stimuli. The visualiser will, it may be concluded, generally respond more quickly to stimuli presented visually, or to visual terms, the audile to auditory stimuli and terms.

According to the Kraepelin methods a number of individuals are required to write out in a given time as many words as possible from a certain sensory sphere. As our vocabulary of words derived from the different sensory spheres varies, a direct comparison of the number of, say, the visual and the olfactory terms is not possible; but the number of terms reproduced by an individual from one sphere may be compared with the number reproduced by another individual from the same sphere.

The secondary devices suitable for determining imagery types include the kinds of error made

[1] See Chapter VII. [2] Chapter VIII.

by different individuals in speaking, reading, and writing. The visually-endowed individual confuses words which appear alike but sound different; the audile makes just the opposite mistake. In learning nonsense syllables the visualiser attends to the consonants more than to the vowels, because the varying lengths of the former are more attractive to the eye; the vowels, on the other hand, receive more attention from the audile. The visualiser has a better local memory than the audile, recalling easily the position in a book where a passage occurs; in retaining a passage, however, the visualiser makes more omissions than the audile. A special device employed to determine the visual type is to require the subject to spell long words backwards. As the visualiser has all the letters before him he has much less difficulty in accomplishing this than the audile, who is dependent for the reproduction on the natural order of the letters of the word and can reverse this only with difficulty.

An experimental study of ideational types of American upper elementary and high-school pupils on the basis of ten different methods, including most of those just mentioned, has led the investigator to the conclusion that there is no reliable method for determining the imagery of children. The tendencies found in one test are contradicted by those revealed in another.[1]

We pass now to the important questions, how such imagery types are distributed in children, and wherein lies the educational significance of the doctrine. Un-

[1] See *Journal of Educational Psychology*, vol. iii. p. 60.

fortunately, final answers cannot be given without a systematic investigation of the imagery of large numbers of children of the different ages, and this has not yet been undertaken.

A fundamental question for the pedagogical significance of the imagery types is whether we have in them innate tendencies which from the outset dispose some individuals to employ visual imagery, some to think in vocal sounds, and others to apply the motor and tactual elements; or whether these differences are the result of education and training, that is, whether it is possible to change the type or not.[1]

Experimental psychologists find that the type of imagery used can be altered by laboratory practice, and Baldwin considers that the method of learning may determine the type used.[2] "The part played by the visual and motor memories, in my own case," he says, "is seen in the fact that when I wish to speak in any language but English, the German words come first into my mind; but when I sit down to write in a foreign language, French words invariably present themselves. This means that my German is speech-motor and auditory, having been learned conversationally in Germany, while the French which was acquired in school by reading and exercise-writing is visual and hand-motor." Dispositions of a certain type may, however, be so weak that they are incapable of improvement: a change to this form is then impossible and we recognise in it a defect in imagery type.

[1] *Cf.* Offner, M., "Das Gedächtnis," p. 217.

[2] "Mental Development in the Child and the Race," pp. 412–13.

Children generally favour concrete imagery, while adults mainly use verbal imagery. Until fourteen years of age and over, children work more with concrete than with verbal imagery, although under the influence of school instruction they more and more come to think in words.[1] Whether the types are differently constituted in the different years of age is still undetermined. Children, like adults, when using concrete imagery mostly visualise; in respect to verbal imagery they mostly belong to the acoustic-motor type. With females visual imagery remains throughout life more in evidence than acoustic-motor. The types, concrete and verbal, are very seldom pure types, other elements accompanying the predominating form according to the object imaged. All types appear to be alterable in the sense that weak aspects can be improved by training. Present-day instruction, in Meumann's estimation, tends to develop auditory and vocal imagery and to suppress concrete visual imagery.[2]

How far pure types occur, and to what extent psychical defects exist among children, is important pedagogically, lest a task is enforced which, by reason of such defects, is incapable of being performed. In the investigations which have so far been made with children no case of a perfectly pure type has yet been discovered, and it is an advantage pedagogically that amongst children the mixed type predominates.

[1] For analysis of children's imagery and relative proportions of various forms, see *British Journal of Psychology*, vol. iii. p. 376.

[2] "Vorlesungen," vol. i. p. 492.

The general didactic significance of the imagery types lies in the fact that each pupil is disposed to apprehend the material of instruction according to his preferred form of imagery, either mainly visually, acoustically, or in motor fashion; if a school task corresponds to his imagery type he is at an advantage, whereas when there is no such correspondence he has to attain his end indirectly. The teacher should consequently be acquainted with the imagery types of his pupils in order that he may know what to require of them. It has been suggested that pupils should be arranged in sections or classes according to their imagery types. This demand ignores the psychological fact that by far the greater number of pupils are of the mixed type, and that, by training, the undeveloped elements of imagery in each child can be improved; it also violates the principle that education should not intensify personal idiosyncrasies, but, with the requirements of later life in view, should seek to secure an all-round development.

In addition to imagery types, memory types also exist. As these have been disclosed by the methods adopted in learning "by rote," they may be termed "learning types." We can distinguish the slow and the quick type of learner—the former seems to be the rapid forgetter also;[1] then the purely mechanical learner who adopts no devices but learns by mechanical reiteration, and the mnemotechnical learner who cannot manage without the formation of helpful associations. Moreover, there are the

[1] *Cf.* Chapter VII., above. Also Offner, M., "Das Gedächtnis," p. 209.

analytic and synthetic types, the former directing the attention mainly to the whole, of which the particular elements are regarded as members, the latter connecting the particulars synthetically one to another.[1]

On the basis of the individual differences in attention which we have mentioned above,[2] it has been maintained that types of attention exist. Meumann has distinguished between individuals with typically concentrative or intensive attention and others with typically distributive attention. Scientific investigators usually belong to the former, business men, military geniuses, etc., to the latter. Men like Napoleon and Cæsar are said to have possessed the power of distributive attention in a high degree, the latter being able, it is said, to dictate four letters while writing a fifth.[3] Freeman, however,[4] maintains that the results in his investigation do not support this sharp division into two types.

Messmer has proposed another classification of types, the objective and the subjective, or the fixating and the fluctuating types. The representatives of the former have a limited field of observation, in which, however, the impressions are clearly apprehended; the latter attend less to the objective stimuli than to the ideas used to interpret them. But Freeman likewise denies the validity of such a

[1] Offner, p. 210.

[2] Chapter IV., above.

[3] *Cf.* Whipple, "Manual of Mental and Physical Tests," p. 279.

[4] "Pädagogisch-psychologische Arbeiten," vol. i. p. 138.

classification, stating that the characteristics are variously combined, and that in his investigation the subject with the greatest range of attention was the subject whose judgments were most correct.[1]

Opinions in regard to the existence of types of attention are consequently far from being unanimous.

Finally, we pass to a problem belonging to the synthetic treatment of endowment—a problem which is of importance pedagogically, namely, whether some aspects of endowment and some mental characteristics are reciprocally exclusive and whether others exist which are mutually dependent.

Good memory is, for example, sometimes believed not to coexist with logical power, nor concrete imagination with the capacity for abstract reflection. The question arises whether these aspects of endowment are really reciprocally conditioned, or whether the inverse relation only results from the practical difficulty of simultaneous training. The latter is the case, and there seems to be no inherent hindrance to an all-round development of the individual. This general principle has been confirmed in one particular instance by Winch,[2] who sought to determine how far substance-memory, that is, memory for ideas irrespective of their verbal expression, is in school children compatible with imagination, in the sense of invention or productive imagination. He shows, contrary to popular opinion, that there appears to be considerable positive correlation in school children between the two functions, or sets

[1] "Pädagogisch-psychologische Arbeiten," vol. i. p. 136.

[2] *British Journal of Psychology*, vol. iv. pp. 95–125.

of functions, employed in memorising the substance of stories and in inventing stories under given conditions.

Quite as important as the question of the inverse relation of functions is that of the mutual dependence of one upon another.[1] Certain qualities of attention, for example, appear regularly to accompany certain description types; the fixating quality of attention, for example, is apparently the cause of the describing and analytic types of apprehension. The synthetic and the analytic methods of learning may stand in close connection with the synthetical and analytical forms of attention. Sense-memory congenitally strong in one department determines the one-sided imagery type, an all-round developed sense-memory the mixed type; acoustic-motor imagery facilitates in retention the formation of successive series, visual imagery the simultaneous reproduction of concrete content. Rapid adaptation of attention seems to be accompanied by rapid loss of adaptation. These results have been obtained with adults and still require confirmation in respect to children.

Investigations on these lines should provide us with the data necessary to determine comparatively the typical differences in the child and the adult. We are still without means of determining whether, for example, the child's excessive use of concrete imagery is responsible for the slow development of abstract thinking and the slow rate of reproduction in association tests; also whether the child's limited capacity for learning, in comparison with the

[1] Thorndike, "Educational Psychology," pp. 185–86.

adult, is due to weak concentration of attention or to some property of memory independent of attention; or, again, whether the more permanent retention of the child is a result of the greater number of repetitions required in learning, or indicates a special property peculiar to the child's memory. Experimental Education must, for the present, be content with raising these questions.

The results of certain experimental investigations on the question of compensating for defects by means of training are available and worthy of mention. A typically slow adapting learner, it has been found, can become a typically rapid adapting learner; a defect in the capacity to withstand distractions can to a large extent be remedied by habituation; and the extension and distribution of attention may also be improved by training. The attempt to cultivate a fixating type of attention in an individual of the fluctuating type meets, however, with but slight success, and weak elements in concrete visual imagery may be strengthened without any effect on verbal imagery.

As a practical outcome of this, means should be found to discover early any defect in the child's endowment, and suitable exercises devised whereby the child, however endowed, can be trained to satisfy the normal requirements of the school. From the results of memory tests, and from the fact of the dependence of imagery type on training, it is maintained that much may be done by formal training of the laboratory type; and when by adequate analysis of the work of the child in the various

school subjects we are able to discover the cause of weakness in a given subject and to apply appropriate remedial training, there will be no excuse for any child remaining backward.

The doctrine of endowment then demonstrates that individual differences in the endowment of children are too great to be disregarded. This does not imply that the curriculum and the organisation of schools should be specially adapted to each individual, since these are not determined by psychological but by social considerations, which have regard only to the individual with standard endowment. But in the treatment of individual pupils by the teacher this requirement ought to be met. The teacher should be able to determine readily the various aspects of his pupils' endowment and require them to apply the methods of apprehending and learning corresponding to their endowment. His methods, and his requirements and estimates of the pupils' efforts, should also make allowance for the individual endowment of pupils, more especially of pupils of exceptional endowment. He should also seek to employ, as means for compensating for differences and defects in endowment, the ordinary school exercises and subjects, and at the same time make the pupils conscious of their value for this end.

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CHAPTER XII

THE MENTAL WORK OF THE CHILD

IN turning to consider the mental work of the child we are passing from what is mainly of psychological interest to what is primarily of pedagogical significance. Although the results at which the mental work of the child aims are dictated by educational considerations, we are dependent on the psychological analysis for the knowledge of the processes involved. All investigations of the mental work of the child must consequently proceed from the psychological analysis.

The subject comprises three problems: (1) how far the principles conditioning the mental work of the adult apply to the child; (2) under what conditions the main types of mental work can best be accomplished, a task characterised as the technique and economy of learning; (3) the application of the technique and economy of work to the different school subjects.

It is still undetermined whether the conditions affecting the work of the adult apply to the child, or whether the child of school age exhibits in this respect typical differences from the adult. The con-

ditions of continuous mental work have, in the case of the adult, been determined with considerable accuracy, but they have not yet been investigated with children. From the results of tests with children on fatigue certain inferences can nevertheless be drawn as to the nature of their continuous work. Thus we know that the younger the children the sooner they tire, and that throughout school life, and even beyond it, fatigue arises earlier and is more pronounced with the child than with the adult. The work of the child is likewise more influenced by adaptation, that is, children as a rule do not readily attain their maximal efficiency. The general conditions of adult work doubtless apply to the child, but a systematic determination of these, and an exact comparison between the child and the adult in this respect, are still wanting.

The experimental methods of determining the conditions of work are numerous; deleting a certain letter in a printed text or the addition or multiplication of series of figures may be cited as illustrations.[1]

The work curves of all individuals exhibit fluctuations. These are attributed by Kraepelin to the following causes:[2] Practice, which tends to increase the amount of work done; fatigue, which generally has the opposite effect, but at a certain stage may

[1] Myers, C. S., "Text-Book of Experimental Psychology," ch. xiv.; "Introduction to Experimental Psychology," ch. vi.; and Whipple, E. M., "Manual of Mental and Physical Tests," chaps. xxxvi., xxxvii.

[2] *Cf.* Offner, M., "Mental Fatigue," translated by Whipple, pp. 62–73.

increase the work quantitatively, while rendering it qualitatively inferior; habituation, which enables the subject to overcome distractions, and which brings about the disappearance of unpleasant feelings and inner tensions; incitation or "warming up," which manifests itself at the beginning of the work; spurts, which arise from transitory tensions of the will, more especially when the subject becomes aware that he is slackening, or when he fears the approaching termination of the work; loss of practice-effect, which occurs when the work has been interrupted for a long period, and which decreases the amount of work; lastly, recuperation or the renewal of energy lost by fatigue. Examination of the fluctuations in the work curve which are due to these causes enables individuals to be classified into certain general work types, but it is not maintained that the same individual belongs to the same type in all forms of work.

In his investigations with continuous counting Meumann claims to have found three different types of workers amongst adults.[1] The first type attains maximal efficiency at the start, and thereafter the work decreases regularly with various small fluctuations; the second type attains maximal efficiency after a definite time, varying with the character of the work; with the third type the maximum of efficiency is displaced markedly towards the conclusion of the work, and is sometimes only attained after one or more hours of continuous work. The first type is characterised by easy adaptation and rapid

[1] "Vorlesungen," vol. ii, p. 10. *Cf.* Whipple's "Manual," p. 335.

fatigue; the second by relatively late adaptation and less rapid fatigue; the third has an exceedingly slow adaptation, but great endurance, and offers the most resistance to fatigue. These general work types must be regarded merely as quantitative work types, as no account was taken of the qualitative differences in the work of the individuals tested. The existence of qualitative types has also been suggested, but our knowledge of these is still indefinite. Whether this classification holds for the work of children is likewise undetermined.

We now pass to the economy and technique of learning, and must confine ourselves mainly to that aspect of the subject which has been most thoroughly investigated, namely, the economy and technique of memorising. Economical learning aims at learning in the most advantageous manner, that is, in the shortest time, with the simplest means, and with the least expenditure of energy. Technique of learning is the adoption of the right methods and the command of all the conditions and of the whole procedure which serves most favourably for learning. Perfect command of the technique results in the most economical learning, and the importance of a knowledge of the methods of learning to the child is obvious.

The conditions which affect learning, either favourably or unfavourably, may be classified into outer or objective and inner or subjective.

The objective conditions operative in the learning of memory material under laboratory conditions include the size and legibility of the characters presented, and, connected therewith, the length of

exposure; the ease or difficulty of the pronunciation of the various syllables, those difficult to pronounce being usually difficult to remember; the *tempo* of learning; rhythm; the influence of vocalisation, whether speaking aloud, half aloud, in an undertone, or without vocalisation; the distribution of repetitions over a longer or shorter time; the accumulation of repetitions; learning by the entire method or by the sectional method; whether the material is read to the subject or read by him; and the nature of the material learnt.

That the time of exposure and the difficulty of pronunciation are not unimportant in learning needs no explanation. The views of experimenters, however, are not unanimous in respect to the *tempo* of learning. Some maintain that the quicker the learning the better; but it may be objected that the more rapidly one learns, the less effective, by reason of its transitoriness, will be the single repetition, and that the time saved in reading will have to be expended on a greater number of repetitions. Meumann maintains that the *tempo* should be adapted to the stage of learning; that at the outset, when the series of syllables is relatively unknown, it is better to proceed more slowly and thereafter to learn more rapidly. This view confirms the importance now attached to the first reading or presentation of the subject matter. It appears[1] that the length of time required for a learner to master all the points in a

[1] Pyle, W. H., "One Function of the Teacher in Memory Work," *Journal of Educational Psychology*, vol. i., pp. 474–76. *Cf.* Watt, "Economy and Training of Memory," p. 47.

given material is in part dependent on the number of original errors which have to be unlearned. Learning thus regarded is a process of eliminating mistakes. It will be found economical, then, at the beginning of any process of learning involving memorising to take plenty of time to make the impression clear and vivid and to get the right meaning, before proceeding to repetition.

All experimenters have found that learning without rhythm is considerably more difficult than rhythmic learning; in fact, some individuals find it quite impossible to learn without rhythm.[1] The rhythm or metre which seems to be most favourable is the dimeter. Apart from this, it is most advantageous to group the syllables into a series of twelve and, in learning, to pause at the end of the sixth; some subjects, however, find it better to arrange the twelve syllables into three fours. The conjecture has been hazarded that different nationalities might have different rhythms, but representatives of fourteen different nations were tested at Zurich, and it was found that the various rhythms were quite irregularly distributed amongst them.

With regard to the influence of vocalisation, learning half aloud has been found most favourable, but with young children speaking in an undertone is in a surprising degree better.

The distribution of repetitions is an extremely important factor in learning.[2] The question is whether the repetitions should be spread over a long

[1] *Cf.* Watt, "Economy and Training of Memory," pp. 69–70.
[2] *Ibid.*, pp. 55–57.

period of time in which after one or more repetitions a pause ensues, or whether time and repetitions are saved when the repetitions are accumulated at a single sitting. The results of repeated investigations show that the more extended the distribution of repetitions, the easier is the learning and the better the retention. Twelve periods of ten minutes' practice, for example, produce better results than six of twenty minutes, and considerably better than three periods of forty minutes. The reason for this is twofold: with fewer repetitions at a time fatigue is not so likely to ensue, but the main factor is the age of the associations involved. The older the associations, the more efficacious are they and the more easily can they be reproduced. Thus, when repetitions are extended over a considerable period, on the second day associations of twenty-four hours' standing are being dealt with, and on the third day associations of two days' standing. The more the repetitions are distributed, the more does one work with old associations, whereas when all the repetitions come together, recent associations only are employed, and the effect of their consolidation is lost.[1]

With increase in the accumulation of repetitions the effectiveness of each repetition decreases. Thus on the first day a certain number of repetitions is found necessary; to relearn the same material the following day fewer repetitions are required, and these may be regarded as additional to those of the

[1] Myers, "Text-Book of Experimental Psychology," pp. 171–78; "Introduction to Experimental Psychology, p. 81, *cf.* pp. 82–85.

first learning. But if the material has to be so learnt the first day as to be reproduced on the second day without re-learning, the number of additional repetitions is out of all proportion to the usual number required for re-learning. This is explained by the fact that, as learning proceeds, the single repetitions lose in effectiveness. In school practice it is important to recognise that the number of repetitions necessary for perfect reproduction cannot be regarded as the standard for continuous retention; the latter requires many more repetitions. Extreme concentration of attention during the process of learning, it may be remarked, reduces the number of repetitions necessary for immediate reproduction, but for prolonged retention the number of repetitions seems to be the determining factor.

The method of learning adopted is an important condition in memorising. There are three main methods, termed, respectively, the entire method, the sectional method, and the mixed method.[1]

According to the entire method, one learns by repeating the material right through from beginning to end. With the sectional method the material is divided into sections—for example, verses of a poem; each section is memorised independently, and then all the sections are connected. Of these two methods the "entire" is by far the more advantageous. In it attention is more uniformly sustained than in the sectional learning, since new material is continually

[1] *Cf.* Offner, Das Gedächtnis, pp. 62–66; Watt, "Economy and Training," pp. 48–53; and Myers, "Introduction to Experimental Psychology," pp. 85–87.

being presented as we pass from the beginning to the end. In sectional learning there is a tendency to repeat the first sections oftener than the succeeding, whereas with the entire method this uneven distribution of repetitions is avoided. In entire learning no redundant associations are formed, only those connections being made which are operative in the final reproduction; whereas in sectional learning associations are formed between the last word of the section and the first word, not of the succeeding section, but of the same section; these are quite valueless, and hinder the successful reproduction of the whole. Lastly, by the entire method the material is impressed on the mind as a whole; the sense of the passage thereby affords some assistance in learning; many individuals also learn better when sections are regarded as members of a whole. The entire method has, however, the disadvantage that sections already memorised are repeated; thus the whole has to be repeated throughout until the difficult passages are mastered. A further objection to the entire method is that the distribution of attention is not uniform throughout; the intensity of attention appears to be regularly relaxed towards the middle and to be somewhat greater towards the beginning and the end of the passage: the middle part thereby tends to suffer in memorising.

The mixed method seeks to secure the advantages of both the entire and the sectional methods while avoiding their defects. It requires that the material should be divided into sections, and that after each section a pause should be introduced in the reading;

the principle of entire learning is nevertheless followed, as the individual reads through continuously from beginning to end. With this method attention is not so liable to fatigue as with entire learning, and the weakness of associations in the middle sections is thereby avoided. When the material is divided into sections and a difficult section occurs, this can after a suitable pause be attacked with renewed attention, and if the section is not immediately repeated no unnecessary associations are formed. When great irregularities in the material occur, the entire method should first be adopted, until the learner becomes conscious of the definite parts which are of special difficulty; these should then be learnt separately, and thereafter a return should be made to the entire method. The grade of endowment of the child appears, according to Meumann, to affect the method of learning: with highly intelligent children, and those who learn easily, the advantage of the entire method is most quickly and clearly seen.

The entire method and the mixed method are each considered better than the sectional method for both immediate reproduction and retention; but in regard to the comparative values of the two former there is not the same unanimity of opinion. Meumann's view is that for immediate reproduction the mixed method is most favourable, and that for retention the entire method and the mixed method are of equal value; although he admits that with very uniform material the entire method may have the advantage, yet he maintains that this advantage is lost through

the additional number of repetitions required for learning material of unequal difficulty, and he accordingly concludes that the mixed method is, on the whole, the most economical.

The pause which succeeds learning has considerable effect on retention. A condition of perfect rest after learning gives the best results.[1] Even looking through a book of commonplace pictures is said to lessen the effect of any preceding memory work. On ceasing the effort to learn, therefore, it is not advisable to turn the mind at once to another subject. It is better to allow it to rest for some five minutes.[2]

Arnold lays down the following conditions with regard to the pause in continuous work. "During continuous work, the impulse to work gradually decreases, while the fatigue actually gradually increases. A pause with rest should then come when the impulse to continue the work is weak, and while the effects of fatigue are strongly in evidence. If, however, the impulse to work is strong and the fatigue is not great, a pause may be unfavourable to good results. The length of the pause, too, affects the work immediately following. If the pause is too long the effects of practice may be greatly diminished, and the impulse to work may become very weak. If the pause is too short the impulse may be interfered with, and the effects of fatigue may still be strong enough to hinder further effort."[3] Wimms

[1] *Cf.* Myers, "Introduction to Experimental Psychology," p. 81.

[2] Watt, "Economy and Training of Memory," pp. 66, 67.

[3] Arnold, F., "Interest and Attention," pp. 64–65.

has also demonstrated that with difficult forms of work longer pauses do not give better results than the pause found most beneficial for easy forms of work.[1]

With regard to the other objective conditions of learning we may consider whether it is better that the learner should read the material himself or have it read aloud to him. The former is found to be the easier both for the adult and for the child. The principle is doubtless subject to modification by reason of the endowment of the learner, more especially in respect to his imagery type. The visualiser would naturally learn more easily by reading, the audile by hearing, but some audiles learn even better by reading than by hearing, owing partly to habit and partly to the fact that in visual learning more associative elements co-operate.

The appropriateness of the material, in respect both to quality and to quantity, determines to some extent the ease of learning. With unintelligible material it is found most economical to make the quantity learnt at one time as great as the powers and training of the learner allow. Tests on an adult, to determine the most economical unit for committing poetry to memory, show[2] that with passages up to 240 lines learning by wholes is without exception more economical than learning by parts. The relative saving, it appears, is much greater with long

[1] *British Journal of Psychology*, vol. ii.

[2] Pyle, W. H., and Snyder, J. C., "The Most Economical Unit for Committing to Memory," *Journal of Educational Psychology*, vol. ii. pp. 133–42.

sections that require more than a single sitting, the most economical method in this case being to devote thirty or forty minutes at a sitting, the exact amount of time depending upon the general condition of the learner. In the learning of selections longer than, say, 240 lines, the most economical procedure, it is suggested, might be to divide the matter into large units which in themselves constitute thought-wholes, to commit these to memory separately, and then to memorise some device to hold together the separate parts. Experiments of a similar nature require to be undertaken with children of various ages to determine the most economical unit, in regard both to the amount of material of various kinds to be presented, and to the time to be spent at the various stages of memorising.

Intelligible material is considerably easier to learn than unintelligible material, and the more connected the material the greater the ease of learning. Learning of intelligible material is therefore dependent on the degree of understanding brought to the material. The first readings of a passage serve mainly for the understanding and arranging of the material. Certain outstanding features are first observed, and these serve as props for the whole, or as points around which the rest of the content gathers. The more definitely and rapidly we apprehend these main steps in the train of thought, the more quickly the mental appropriation proceeds. It consequently follows that, in teaching, all the material should be exhaustively explained, and reference made to the construction or form of development of the poem

or piece of prose. When the main ideas of a passage are clear to the child, half the work of memorising is done, since, when these are fixed in their relative order either logically or concretely in imagination, the rest of the content may readily be added.[1]

The inner or subjective conditions of learning are more difficult to determine and control than the objective conditions; the ideal in learning, for experimental purposes, would be to keep these conditions constant and uniform.

In learning, the first requirement is the regulation of attention. The more intensely attention is concentrated on the learning, the more quickly, as a rule, is learning performed. Uniformity of attention is an important factor when the passage to be memorised is long or involved, and the whole has to be impressed equally on the mind. The normal fluctuations in attention which take place in continuous work have not yet been sufficiently investigated to enable us to control their effect on learning. The uniformity of attention depends on the nature of the presented material—intelligible and interesting material securing attention readily—and also on the method of learning adopted, each form of method being accompanied by typical variations in uniformity of attention. As attention is greatest at the beginning and towards the end and flags towards the middle, the sectional or the mixed methods of learning would, in respect to uniformity of attention, give more favourable results than the entire method. Duration of attention is important in learning long or involved

[1] *Cf.* remark of Lewis in Chapter VII.

passages. Great individual differences occur in this respect, attention with some individuals fatiguing easily, whereas with others attention is enduring. It is important in teaching to know whether a child possesses an enduring or an easily fatigued attention.

Adaptation of attention is another important inner condition. On this depends the difference between the so-called slow and the rapid learners. The quick learner has the power of easy adaptation, the slow learner a slow adaptive capacity, that is, the former attains his maximal efficiency at the outset. A slow adapting learner can, as has been stated above, be trained to rapid adaptation, so that this characteristic does not seem to be the expression of an innate disposition.

The emotional disposition of the learner is an important condition in memorising, pleasurable feelings favouring memory work and unpleasant emotional states affecting it adversely. All feelings exceeding a certain limit, however, prejudice memorising, so that the very zeal of the beginner may be a hindrance; the well-balanced emotional disposition of the practised subject gives the best results.

Tensions are also important inner conditions. Concentration of attention is usually accompanied by muscular tensions. The beginner introduces too many, with the result that the memory activity, instead of being assisted, is paralysed: a well-balanced condition is here again the most favourable.

With tensions is apparently connected the

nomenon of volitional spurts. In continuous mental work we may become aware that attention is flagging, or that the desired result is not being attained, and then we incline to stimulate ourselves. These spurts have apparently both an intellectual and a motor aspect, the intellectual consisting in making us conscious of our work and of our resolve to keep ourselves to it, the motor in the appearance of tensions in the muscles controlled by the will.

The general physical and mental condition of the learner also influences his power of learning, a learner in good condition accomplishing more than one in poor form; it is consequently absurd to require the same amount of mental effort from children in different states.

The degree of practice which a learner has had also affects his power of work. In experimental tests an attempt is made to control this by securing the so-called maximal practice, or, when this is not possible, to make the tests with subjects at the same stage of practice.

The imagery type of the individual is likewise an inner condition, influencing his work.

Knowledge of the manner in which they are to be tested, influences the method of learning of individuals. Into this knowledge of the task required there enters a volitional factor, since the will attunes itself to the nature of the test. It is the person who has the will to learn who learns; when this is not present a greater number of repetitions is found to be necessary. Meumann regards all progress through practice as a volitional phenomenon.

To this arousal of the will is related what is denoted by the term interest. That learning which awakens interest in the learner is the only kind of learning that improves with practice and is retained with certainty. The conditions required in memory experiments for such interest have not yet been investigated, but it appears to be a highly complex state.

For the pedagogy of learning it is important to note that the learning itself influences the progress made. Learning, it appears, passes through certain stages. The first stage is that of adaptation and orientation. The first reading serves for adapting the learner to the task and enables him to know what is required of him. In the learning of nonsense syllables it serves for discovering the most effective learning rhythm and becoming acquainted with the forms, visual and acoustic, of the syllables. The second stage is that of passive reception. The learner impresses the material by reading, hearing, and speaking, and maintains throughout a receptive attitude. Then follows the third stage, that of attempting to reproduce, or what may be termed anticipatory testing. This stage is observed in the procedure of the subject who tends to turn aside from the material and mentally anticipate what is coming. From certain experiments[1] it seems that such recall during the process of learning, or immediately afterwards, is a great economy in memorising. The

[1] Abbott, Edwina E., "On the Analysis of the Factor of Recall in the Learning Process," *Psych. Review*, Mon. Supp., vol. xi. No. 1.

fourth stage consists in impressing on the mind the passages which are found to be imperfectly learned and in fixing the associations binding the whole together; on the successful attainment of this the feeling of the ability to reproduce is based. In this last stage the emotional disposition of the learner alters markedly. The first stage is characterised by displeasure and tensions, or is accompanied by changing dispositions, but as the learning proceeds, these give place to pleasurable feelings.

In memorising, an important condition is the appearance at the right time of the feeling that the material has been mastered. In the emergence of this feeling there are great individual differences: with quick learners it comes early and induces premature testing; with cautious natures it often appears too late and the subjects themselves are surprised at their ability when called upon to repeat what is being learnt. Through practice in learning this feeling becomes a more reliable index of perfect learning. Teachers can here assist pupils by requiring them to attend to this inner signal, and, according to the temperament of the child, repress those in whom it comes too early and encourage the over-cautious.

What has been accomplished for the technique of memorising requires to be done for all the formal mental activities which are involved in instruction, namely, apprehension, observation, testimony, reasoning, etc.; and that part of Special Didactic which treats of the procedure of the child in the various school subjects must in the same manner be experimentally determined.

Of the general conditions of learning we may instance that of training. Here we must distinguish a general training from special training. An individual may possess general training in observation or special training in visual observation. The relation of these to each other can only be determined by experiment. The question is still undecided whether special training spreads beyond the practised sphere—for example, whether training of a special memory, say the tone or number memory, improves concomitantly the whole memory in respect to the general capacity of impressing and retaining. Connected with the problems of concomitant training or transfer of training, there are the further questions, of considerable educational interest, namely, in what progress through training consists, and what are the limits of progress brought about by training. Are these general limits, or limits for each individual, beyond which no increase of his powers is possible? The loss of practice-effects, too, is interesting. On what conditions does it depend, and at what rate is it brought about?

The treatment of these questions can best be illustrated by considering the results of memory tests. Is there a general memory training? Can we by formal memory exercises, always confined to definite material, not only improve the memory for that material, but also improve the memory work on other materials? Meumann tested all the special memories of certain students and then subjected them to a training for thirty days in memorising nonsense syllables: thereafter he re-tested all the

special memories. The result was that the special memories of all the subjects taking part were found to have improved, the greatest improvement occurring in the memory activities most closely related to that trained formally. The training in nonsense syllables improved most the memory for numbers and that for letters; less improvement was shown in retention of words, still less in the memory for prose passages, and least in that for poetry.

In accounting for this transfer Meumann admits that there are certain psychical functions involved in the training which are common to all forms of learning, and on whose co-operation the memory activity is dependent. These include attention, development of a favourable general attitude, suppression of superfluous movements and tension, use of the most appropriate forms of imagery, acquisition of uniform emotional disposition, avoidance of mental uneasiness, acquisition of greater self-confidence and of the ability to accomplish the task. These, however, Meumann refuses to regard as supplying an adequate explanation, since they do not explain the greater improvement of the more closely related memories. He consequently admits a close psycho-physical relation amongst the various memories, which is greater according as the memory functions are the more closely related, and which makes possible the concomitant training of allied functions.[1]

[1] For enumeration of instances of transfer in various mental spheres see J. F. Wallace Wallin, "The Doctrine of Formal Discipline," *Journal of Educational Psychology*, vol. i. pp. 168–71.

Winch, as already indicated,[1] maintains that improvement through practice in rote memory is followed by improvement in substance memory for stories. Fracker,[2] who has also subjected to special investigation the question of the transference of training in memory, attributes the transference, where such exists, to the use of identical elements in different tests, and of these elements the most essential is individual imagery.

In view of these discrepancies in the explanation of "transfer," Sleight[3] has reinvestigated the question of formal training in memory work, at the same time subjecting to critical analysis the methods used by Meumann, Fracker, and Winch. The results of his own extensive investigation lead him to conclude that there appears to be no general memory improvement as the result of practice, nor any evidence for the hypothesis of a general memory function. There would seem instead to be a very large number of related and unrelated memory functions, of a more or less complex kind.

The second question regarding the general conditions of training concerns the limits of such training. In memorising there seems, theoretically, to be no limit, but practically the attainment of the perfect reproduction of what is learnt is usually accepted as the limit, and this seems to be in all cases

[1] Chapter. VII.

[2] Fracker, G. C., "On the Transference of Training in Memory," *Psych. Review*, Mon. Supp., vol. ix. pp. 56–101.

[3] Sleight, W. G., "Memory and Formal Training," *British Journal of Psychology*, vol. iv. pp. 386–457.

attainable, a limit being apparently found only in the exhaustion of the powers of the individual.

To determine the duration of improvement gained by practice, subjects have been tested after varying periods, up to 156 days, and it has been found that in some cases there is but little loss, in others none, and in some cases even a gain, after the training has ceased for some considerable time. This last fact is difficult to explain: it would appear as if the training had gone on unaided, and it leads to the oft-quoted paradox that we learn to swim during the winter and to skate during the summer.[1] Naturally no such training takes place in the interval, although there may be a further development of the dispositions left by the training. Many causes doubtless co-operate in bringing about this effect. Recuperation may be instanced: continuous training of an activity generates fatigue, and after a pause we can return to the training with restored nervous energy and with a fresh impulse. Certain inhibitions created by the training may also lapse during the interval, and on the physical side a certain time may be necessary for the physiological processes to set.

[1] James, W., "Principles of Psychology," vol. i. p. 110.

Burt found with a mirror test that children who had begun their first series at an average speed of 103 secs. for the first tracing, and left off at an average speed of 39·6 secs. for the sixth tracing, after a three months' interval resumed with a speed of 34·5 secs., that is, actually faster than the speed with which they left off the first series (*Child-Study*, vol. iv. p. 43).

From tests on illusions it has been found that the most beneficial pauses in the acquirement of a habit are shorter for children than for adults.

Knowledge of the results, or of the progress made, seems to act as an incentive to effort and improves the work done. Judd found [1] in mirror-drawing tests that no progress was made when the subjects were kept ignorant of the accuracy of their work. The experiments [2] on the acquisition of skill in various kinds of work show how important for progress are the emotional disposition and the will to advance, and how the teacher can assist the pupil in learning to learn by providing proper incentives at the critical stages.[3]

In outlining the subject of the economy and technique of mental work for future investigation, it may be useful to indicate Messmer's division of the subject. He has distinguished three aspects of learning —learning being here used in a wider acceptation than is usual in psychology—which he has characterised as the apprehension of the material, the retention of the same, and the power of applying what is learnt. These aspects are not to be regarded as "formal steps" of learning. Messmer requires that sometimes the one, sometimes the other, should be emphasised according to the didactic aim in view. As to the relation of these three aspects, Messmer conceives the first to be contained in the second, and the second in the third. The means for facilitating the apprehension are at the same time

[1] *Cf.* Dearborn, W. F., "Experiments in Learning," *Journal of Educational Psychology*, vol. i. p. 379.

[2] For description see Whipple, "Manual," Test 36.

[3] Book, W. F., "Rôle of the Teacher in Economic Learning," *Journal of Educational Psychology*, vol. i. pp. 183–99.

means for facilitating retention, and the means for improving retention are means for improving the applicability of what is learnt. Messmer thus arranges under the general concept, Learning, the particular aspects Apprehension, Retention, and Application.

Meumann considers that it is not advisable thus to extend the connotation of the term "learning," but prefers the term "mental work of the child," and suggests the following division of mental work: (1) the observation or apprehension of perceptual content and the construction from concrete memory-images of ideas of objects or processes; (2) memorising and reproduction, or the training of the purely associative function, in which the mere retention rather than the perceptual analysis is the important factor, and which, with the processes of reproduction of associated images and of verbal reproduction, forms a whole; (3) the apprehension and reproduction of conceptual and logical knowledge, including analysis of the conceptual activity itself and of its psychical correlate. This can be tested by analysis of those subjects of instruction in which conceptual activity is involved, in mathematics, composition, etc., and by introspection on the mental processes; (4) establishment and extension of the perceptual content, memory content, and conceptual material through repetition and application. Consideration of these four activities of the child constitutes the general doctrine of mental work. To this has to be added the special doctrine of work which analyses the work of the child in the various school

subjects, including not only the intellectual subjects but also those involving the acquisition of dexterity or skill.

A treatment of the work of the child would not be complete if the influences of the environment in which the child works were not taken into account. As illustrations of this we shall select the influence of collective working and of examination conditions.

The question we have to determine is, How does the child work individually and as a member of a class, or how does he work at home and at school? The question can be further specialised according to the age of the child, the individuality, the grade of endowment, the emotional and volitional disposition, the physical constitution, the sex, and the character of the work, especially in respect of the mental activities involved in it. The influence of collective teaching may also vary according to the size of the class.

The only method for determining the value of work done under such varying conditions is to apply tests of equal difficulty, both qualitatively and quantitatively, in the different circumstances.

The results obtained by Mayer and Schmidt at Würzburg demonstrate generally a great superiority of school work over home work and of collective work over individual work. In the class, and as a member of a community, the child accomplishes more and better work in the same time than at home and in isolation. These results are not to be explained by the unfavourable conditions under which home work is executed, for it has been demonstrated that

the majority of pupils quickly habituate themselves to the distractions at home and are but little influenced by them. In general, the weaker children and those who are slow workers gain most by class work: the younger, too, gain more than the older, since they are more in need of the stimulus of the class and of the teacher. The work of the pupils is rendered more uniform, both quantitatively and qualitatively, by class work; fewer differences in the rate of working are exhibited; and the extremes of the mistakes made are not so wide as in home work. This uniformity resulting from collective working accounts for the fact that the weaker pupils gain most by class work. In consequence of this, however, there arises the danger of over-pressure with the weaker pupils, and so the exceptionally weak, or those specially liable to fatigue, should be placed in special classes. It has, on the contrary, been suggested that a certain mixing of the grades of endowment has a beneficial effect, as the weaker are stimulated by contact with the more capable. There are, according to Meumann's observation, certain children in each class who do better work in the restful environment of home, because they are not in a position to overcome the inhibitions aroused by class work.

The effect of examination conditions on the work of the child has been investigated by Lobsien.[1] Fifty-four pupils were required to perform certain arithmetical tests under ordinary conditions and also under examination conditions. The scholars

[1] "Examen und Leistung," *Die experimentelle Pädagogik*, vol. i. pp. 30–35.

were arranged in three groups—good, average, weak —and the amount of work done and the time taken were considered. The results showed that with the "good" group the work done under examination conditions was about 22 per cent. worse than that done under ordinary conditions; with the average group the loss was 17 per cent.; and with the weak group 22 per cent. Examinations, it is concluded, do not therefore provide a reliable test of the capacity of pupils, and the evil effects of examinations are not confined to the weak pupils. Lobsien's results would doubtless have been more reliable had the method of parallel groups been adopted in the investigation.[1]

After the fashion indicated above the various questions of school organisation may be investigated, for example, the influence of the presence of members of the opposite sex on the work of pupils, this being one aspect of the general problem of co-education, the influence of the size of classes, and even of the personal equation of the teacher. When this has been fully accomplished, a scientific basis for school organisation will be available.

[1] See above, Chapter II.

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CHAPTER XIII

MENTAL HYGIENE

MENTAL work involves a certain expenditure of energy and consequent fatigue, which may, under certain conditions, exceed the limit permissible for good health; fatigue can pass into exhaustion and, if adequate recuperation does not take place, the individual may suffer permanent injury. The problem of a mental hygiene of school work consequently arises. It need hardly be remarked that such a mental hygiene has nothing in common with what is termed school hygiene, which concerns itself merely with the physical conditions of school work.

The doctrine of mental hygiene seeks to measure the expenditure of mental energy and the amount of fatigue; to discover the conditions on which these depend; to determine the amount of exertion and the degree of fatigue which it is not safe to exceed, the harmful consequences resulting from fatigue, and how these can be obviated; and to investigate the various recuperative factors. The expenditure of energy occasioned by mental work is measured mainly by the resulting fatigue, and, although the

doctrine of mental hygiene is not exhausted by the measurement of fatigue, the treatment of the subject has largely centred round this aspect: we are consequently led to consider, first, the nature and measurement of fatigue.

The concept "fatigue" has to be distinguished from the subjective experience of tiredness or lassitude.[1] Fatigue and tiredness are not synonymous. Fatigue involves the actual diminution of energy in the organism; tiredness or lassitude is the feeling which we experience when the organism has more or less exhausted its powers. Lassitude usually acts as an index to the state of fatigue, but the two do not necessarily coincide. An individual may be fatigued without being tired and *vice versa*, the feeling of tiredness arising at the beginning of work and coexisting with quite fresh energies. This incongruity between the feeling of tiredness and the actual state of fatigue is characteristic of many individuals;[2] there are some who feel tired when their energies have not been in the least exerted or certainly not exerted to the utmost, and others seldom, if ever, become aware of more than a very slight degree of exhaustion. This latter condition is an extremely dangerous one, because the feeling of tiredness acts as a protection against the excessive

[1] *Cf.* Offner, "Fatigue," Whipple's translation, pp. 19–20.

[2] Thorndike states that, from a comparison of the reports of subjects taking part in an investigation on Mental Fatigue, it appears that the relation between the feeling of fatigue and the fact of fatigue is not at all close (*Journal of Educational Psychology*, vol. ii. p. 71).

expenditure of energy, and its absence when there is real fatigue may cause an individual to continue working to the point of exhaustion.

Fatigue is of the greatest practical importance in education, due to the fact that it is a necessary concomitant, and indicates an unfavourable condition, of mental work. Excessive fatigue can make mental work absolutely valueless, and if the degree of fatigue exceed a certain limit the whole physical and mental life of the child may be permanently injured.

The general symptoms of fatigue in children are well known. The various stages have been indicated thus by Dr. Taylor:[1] "The picture of a naturally fatigued child is characteristic—his tired, drawn look, his clumsy movements, his listless conversation, his aversion to exert himself, and his readiness to fall asleep. When the condition is passing into a chronic state another set of signs begin to manifest themselves. Thus the morning finds him sleepy and languid, his eyes are dull, his pupils large, and his expression limp and wearied. He drags himself to school slowly, without alertness, his walk is 'tottery' and awkward. In school he lacks attention and responds feebly, his gaze wanders, his attitude is slouching, and he becomes peevish. The same causes continuing to act, matters aggravate, and he arrives at the borderland of actual disease. He

[1] Taylor, D. M., "Fatigue in School Children," *The Child*, pp. 410–14.

Cf. Warner, "The Study of Children," pp. 143–44; and Drummond, "Introduction to Child-Study," p. 175.

becomes pale and pinched, suffers from headache, there is muscular twitching or incoordination, he is more liable to colds and susceptible to infectious disease; stomach troubles ensue, with loss of sleep, and exhausting dreams." It is impossible, however, to rest content with merely a knowledge of the general symptoms: definite measurements are essential if our knowledge is to have scientific value. To estimate rightly the significance of such measurements it is necessary to consider the methods by which they have been secured.

The methods used in measuring fatigue may be divided into two classes, namely, direct and indirect. According to the direct methods, the fatigue which ensues on mental work is measured by mental work itself, and, where possible, through work similar in nature to that which induces the fatigue. According to the indirect methods, the fatigue occasioned by mental work is measured through some secondary attendant or resultant phenomenon of the fatigue. Each has advantages and disadvantages. The advantages claimed for the direct method are that we obtain a much more unambiguous and trustworthy measure of mental fatigue when we measure mental fatigue by mental work than when we measure it indirectly by means of some physical symptom. Thus we can determine the degree of fatigue which has resulted from an hour's arithmetic by getting the class to work similar problems and comparing the number of mistakes made in a given time before and after the hour's work; and this is better than testing the spatial threshold or the motor activity, which

may also be influenced. The effect of mental work on mental work is comparatively well known. In arithmetic, for example, under the influence of fatigue more errors will occur and the quantity done in a given time will diminish. The influence exercised by fatigue on the spatial threshold or on muscular activity is not so definitely known. To the direct methods there are, nevertheless, several objections; the chief difficulty is the evaluation of the results; for standards by which to measure psychical processes are not so readily available as those by which physical characteristics are measured. The indirect methods have, consequently, the advantage that the results can be easily registered: there is no difficulty, for example, in counting the pulse or the rate of breathing, if these are taken as indications of fatigue. But the defects of the indirect methods consist in the difficulty of determining what secondary physical or mental processes are affected by fatigue and whether the change in these is exactly proportional to the degree of fatigue.

Three forms of the direct method of measuring fatigue can be distinguished, but the first only is strictly direct. We can determine the state of fatigue by changes in the mental work itself. This can be done in the ordinary course of the work without special tests; or by means of special tests which may either be with similar material or with material of a different nature. In illustration of the first method, we can note the amount performed, and the number of mistakes made, in the course of the

first ten minutes of an hour's arithmetic and compare these with what is accomplished in the last ten minutes. The second method employs special tests of the same nature as the work causing the fatigue; thus, to determine the fatigue resulting from arithmetic, special addition or multiplication tests are given before and after the ordinary arithmetic lesson and the results compared. The third method employs another form of mental work than that inducing the fatigue: thus, to test arithmetic, exercises in dictation or in erasing certain letters in a text[1] can be given before and after the arithmetic lesson, and the results noted. The measurement of fatigue by mental work of a different kind to that causing the fatigue involves the assumption that each kind of mental work induces general and not merely local fatigue, and only if this is the case is the use of a different type of material as a test justifiable.

Opposed to the direct methods stands the group of methods using as an index of fatigue a psychical or physical symptom quite different from the work whose fatigue effect it is sought to determine. These methods fall into two classes, which use respectively a psychical characteristic as the standard of measurement, or a physical symptom like muscular fatigue or rate of pulse or of respiration. These latter methods presuppose that fatigue arising from mental work causes not merely a local but also a general fatigue. This view, maintained by

[1] *Cf.* Myers, "Introduction to Experimental Psychology," pp. 118–19.

Mosso,[1] is not, however, always justified as there are cases where after mental work the power of physical work increases considerably; after two or three hours of study, for example, one may with greater zest than usual turn to some favourite game. The measurement of mental fatigue by physical work is consequently somewhat uncertain.

In treating the various means used in measuring fatigue we shall consider, first, examples of the indirect methods, a common form of which is the æsthesiometer method—the æsthesiometer being the instrument for determining the spatial threshold.[2] It has been claimed that the smallest distance at which a double touch can be distinguished on a given part of the skin serves as a measure of mental fatigue. This method has the advantage of simplicity and ready application. Its value, however, has been much disputed, and it may be questioned whether the capacity for spatial discrimination varies proportionately with fatigue, or whether the ratio between the two factors is constant, and there is also the difficulty of determining what threshold should be taken as the standard. An investigation on mental fatigue during school hours undertaken by Miss Martin, with seven girls chosen from the fifth standard of an elementary school, showed that, as tested by the æsthesiometer, the fatigue of the school

[1] Mosso, "Mental Fatigue," English trans., p. 243.

[2] For description and illustration of instrument see Whipple's "Manual," pp. 207–10, and for results got by it pp. 211–17. See also Whipple's translation of Offner's "Mental Fatigue," pp. 31–39, for discussion of method and results.

day did not cause any constant variation in the sensitivity of the children. The only tendency that was observed was a slight increase in the sensitivity after morning and afternoon school.[1]

The accuracy with which movements are reproduced has also been suggested as a test of fatigue.[2] The subject is practised in making angular movements of the forearm; he has, when fatigued, to reproduce such movements blindfold, and the range of departure from the standard movements indicates the degree of fatigue. Meumann maintains that this method discloses a symptom only, and that it is uncertain whether it provides a real measure of fatigue.

A further group of indirect methods are employed to measure by means of physical work the fatigue occasioned by mental effort. This procedure rests on the assumption that physical work decreases under the influence of mental fatigue. The simplest method of so measuring fatigue is to determine by the use of the dynamometer the gripping power of the hand.[3] With this instrument, however, the number of muscles tested is too large, and the measurements recorded are unreliable if different muscles are brought into

[1] Martin, Gladys W., "The Evidence of Mental Fatigue during School Hours," *Journal of Experimental Pedagogy*, vol. i. pp. 137–41.

[2] *Cf.* Offner, "Mental Fatigue," Whipple's translation, pp. 39–41.

[3] For account of instrument see Whipple's "Manual," pp. 74–79, and for discussion of method, Offner's "Mental Fatigue," pp. 23–24, and Mosso's "Fatigue," English translation, pp. 82–83.

play in different tests. Mosso sought to overcome this difficulty by making use of the ergograph.[1] This instrument enables us to measure the amount of work done by the movement of one finger only, the other fingers and the arm being clamped to a table. By the movement of the free finger a weight is raised, and the height reached by the weight before exhaustion of the finger muscles ensues, measures the work done. Quite apart from the difficulty of preventing the subject bringing accessory muscles into play, it has been shown that the ergogram, or record traced in the process of lifting the weight, is influenced by the volitional attitude and feelings of the subject. Of the instruments for recording the diminution of physical work under the influence of fatigue the ergograph is the most satisfactory, and it has been extensively applied. The results obtained are, however, not always trustworthy, as the general objection to the indirect methods holds with the ergograph: it provides an objective symptom of mental fatigue, namely, the reduction in muscular effort, but this is no measure of the degree of fatigue.

The rate of tapping has also been used to test fatigue.[2] Here the rate of tapping when fatigued is compared with the normal rate or with the quickest

[1] For illustration see Mosso's "Fatigue," English translation, pp. 84, 86, 88; Whipple's "Manual," p. 91; Myers' "Introduction," p. 104; Myers' "Text-Book," p. 383. For discussion of methods and results see Whipple's translation of Offner, pp. 24–28.

[2] See Offner, English translation, pp. 28–30, and for procedure Whipple's "Manual," pp. 100–115.

possible rate, and conclusions are drawn therefrom as to the state of fatigue. The objections to the previous methods apply here also, and a state of excitement may be induced by the task, which increases the work done and masks the effects of fatigue.

Of the physiological symptoms indicating fatigue the blood pressure has been instanced: under the influence of mental work the blood pressure is diminished. Such diminution is recorded by the plethysmograph or the sphygmomanometer: the forearm or the upper arm is inserted in a closed chamber containing air or lukewarm water, and the apparatus is so arranged that any variations in the volume of the arm, due to changes in the blood pressure, are transmitted to a recording lever.[1] Meumann states that in his own case there is a considerable diminution of blood pressure after an hour's exacting work.

The retardation and diminution of the pulse and the shallowing of the respiration are also considered to be symptoms of fatigue. These are measured by the sphygmograph and the pneumograph respectively.[2] Increase in the range of accommodation of the ocular muscles has also been recently suggested as an index of fatigue.[3] The symptoms are nevertheless merely indications of physical fatigue, and in

[1] *Cf.*, for description, Myers, "Text-Book of Experimental Psychology, p. 418.

[2] *Ibid.*, pp. 417–18, and "Introduction to Experimental Psychology," pp. 70–71.

[3] Offner, "Fatigue," Whipple's translation, p. 30.

the indirect methods we have no measure of fatigue which can be regarded as entirely free from objection.

The estimating of fatigue by the direct methods, that is, by changes in mental work itself, is not free from difficulties. These difficulties arise mainly from variations in the work curve indicated in the previous chapter. The effect of practice, for example, increases the amount of work done as the task progresses; incitation, or the capacity for getting under weigh, may at the outset lessen the amount accomplished; spurts may increase the work at various points, and the usual terminal spurt tends to counterbalance the effect of fatigue. The results which have been obtained by the direct methods of measurement show at times, instead of a continuous diminution of work, a stage of fatigue in which the work increases quantitatively, while at the same time decreasing qualitatively. It is only at a later stage that the work also shows a quantitative decrease. The results obtained from the direct methods are nevertheless regarded as more trustworthy than any from the indirect methods, since the methods of determining mental fatigue by dissimilar forms of mental work assume that special work concomitantly affects other powers and fatigues these; and since this assumption is not definitely established, the method of measuring fatigue by means of the same kind of work would seem to be the most satisfactory.

Different forms of mental work naturally induce fatigue at different rates, and the following rules

have been stated in this connection. The greater the practice-effect in any work the greater the fatigue; thus, work of which the individual is master may be performed almost automatically without any fatigue. Wimms, however, in his investigations into the relative effects of fatigue and practice produced by different kinds of mental work, found [1] that, whether the task was easy or hard, high improvability frequently occurred with little fatigue, and low improvability with a high degree of fatigue. Work found to be difficult, especially such forms as do not harmonise with the subject's endowment, fatigues more quickly and to a greater extent than that which is adapted to his endowment. Work which is undertaken reluctantly, and which is consequently displeasing, fatigues more than work performed cheerfully.

From measurements of fatigue more practical applications have been made than from any other class of experiments in child psychology or experimental pedagogy. These must at present be accepted with caution. In spite of the uncertainty of these measurements their practical significance must nevertheless to a certain extent be recognised. Their value depends on the fact that many of the above-mentioned investigations have been carried out on considerable numbers of subjects, and that the practical conclusions rest on the average of such measurements. Such averages sometimes disclose general variations when individual measurements give no clear result. The average should obviously be calculated in a manner free from objection, and

[1] *British Journal of Psychology*, vol. ii. pp. 153–95.

this has not always been the case. To acquire value the measurements require to be arranged in groups, under certain points of view; for example, for intelligent children, normal children, and backward children, and also for children of various ages. Only the general results of measurements of fatigue can be dealt with here; for results obtained by various methods separately the reader is referred to works dealing exclusively with the subject.[1]

It is found that very often the physical work of the pupil causes a higher degree of mental fatigue than mental work lasting the same time. After a morning session, in which gymnastics or physical exercises have been engaged in, a high degree of fatigue has been found—the ergograph registering only half the normal amount of work.[2] The effects of a high degree of fatigue last much longer than those of a low degree, and work performed in a state of fatigue is more injurious than a heavier task performed under normal conditions.[3] The effect of physical work on the volitional process is said to cause psycho-motor excitement, whereas after mental work the result is psycho-motor inhibition.

Of the psychical processes memory is usually

[1] *E.g.*, Offner, M., "Mental Fatigue," English translation by Whipple.

[2] Mosso states ("Fatigue," English translation, p. 200): "In my own case I have observed that great muscular fatigue takes away all power of attention and weakens the memory. I have made several ascents. I have been once on the summit of Monte Viso and twice on that of Monte Rosa, yet I do not remember anything of what I saw from those summits."

[3] *Ibid.*, p. 250.

instanced as the one to be first, and most, susceptible to fatigue, but Meumann has found that in his own case this is not so. All the processes involving attention are highly susceptible to fatigue effects. The associative and reproductive processes and the power of judgment are also easily and lastingly affected. School subjects involving these processes, for example, answering questions, writing composition, etc., will consequently be readily affected by fatigue. Meumann has also noticed that handwriting under the influence of mental fatigue becomes smaller, and reading less correct and more conjectural. Mosso, however, found in his own case that when he was obliged to write immediately after a lecture, the letters were larger and the lines less firm than usual.[1]

A recognition of the stages in fatigue is important. In the first stage, as mentioned above, the quantity of work increases, but the quality degenerates; in the second stage the quantity likewise diminishes. If work is still continued there follows a third stage, which varies according to the nature of the individual and the conditions: either exhaustion and inability to work, or a condition of mental excitability and a state of fatigue-fever, occurs. In this condition of increased stimulation the amount of work is again increased, but is hurried and irregular and accompanied by abnormal symptoms, the pulse being weak and rapid, respiration shallow and quick, the muscular apparatus unstable, and movement incoordinated.

[1] Mosso, "Fatigue," English translation, p. 254.

Four types of fatigue or types of work arising from the morning work of the school have been disclosed by experiment.[1] The simplest or falling type is that in which there is a steady decline in efficiency and a steady increase in the number of errors; opposed to this is the rising type, in which there is a progressive diminution of errors. In the third type the curve rises a little at first and then shows an unbroken drop. In the fourth type efficiency falls at first, but then continues to rise to the end of the work.

The measurements of fatigue cannot give a decisive verdict as to the degree or amount of fatigue in schools, primary and higher, since these measurements register only the existence of fatigue, not its degree. Nevertheless, from the results of tests on mental work it may be concluded that only in exceptional cases is an actual harmful degree of fatigue induced by the school work of children. Meumann found with Zurich primary school children surprisingly little fatigue, but in certain cases, usually with weak children, at the end of the afternoon session, when four hours' instruction had been given in the morning and especially when drill or gymnastics was included therein, there was an excessive degree of fatigue. This result was, however, obtained only with physically weak children. In every class there are generally to be found children, usually the mentally and physically backward, specially susceptible to fatigue; some of the more intelligent, who at the same time are physically weak, especially at

[1] Offner, "Mental Fatigue," trans. by Whipple, pp. 75–76.

periods of rapid growth, also evince conditions of excessive fatigue. The average child of the primary school is not fatigued to any injurious extent by school instruction. This has been confirmed with English children by Miss Martin[1] and by Winch.[2] The same cannot be said for pupils of higher schools, classical or modern: fatigue to an injurious degree has been found in such schools, and this fatigue continues throughout the school year. Winch[3] found that evening school students, who were at work throughout the day, were so fatigued after the first half-hour's instruction as to render the remainder of the evening's instruction practically valueless, and this in spite of the opinions of some of the teachers, that their pupils were so fresh that even at 11 p.m. they could not be induced to go home.

Whether the effects of fatigue accumulate throughout the session is still in dispute. This permanent fatigue may exist with the decidedly weaker children, but with the average child it is not likely to occur.

The question of over-pressure is naturally connected with the question of accumulative fatigue. This is not merely a question of fatigue, but is also a practical pedagogical question. The overstrain is usually due to the burdening of the pupil's mind with unnecessary material, which is forgotten imme-

[1] *Journal of Experimental Education*, vol. i. p. 145.

[2] *British Journal of Psychology*, vol. iv. p. 341, and *Journal of Educational Psychology*, vol. iv. p. 27.

[3] *Journal of Educational Psychology*, vol. i. pp. 13–23, 83–100.

diately after he leaves school. If over-pressure appears in the majority of the pupils of a school, the curriculum or the methods of teaching demand alteration.

In respect to the influence of age it is found that the younger children are more liable to fatigue than the older. Children of six often show signs of fatigue after an hour's or even half an hour's instruction, whereas such symptoms are evident with pupils of thirteen or fourteen only after the third hour's instruction. The fatiguability of children appears to diminish with age. During the pubertal period, however, fatiguability again increases, and this should be recognised in school; and as the age of puberty is different with boys and with girls, a difficulty arises in co-education. The number of pupils in the class affects the fatiguability; the fewer the pupils the greater is the attention paid to each, the more is demanded of them, and consequently fatigue is increased.

The time-table or the arrangement of school subjects in a single day and throughout the week has a considerable influence on fatigue. The most fatiguing subjects should be put earliest in the day; the second period is, however, better than the first. A fairly difficult subject should come at the beginning of the day and the second period should be devoted to the most difficult; the easiest subjects should come at the close of the day. Gymnastics and music are not to be regarded as recuperative, and by reason of their slight educational value should be relegated to the end of the day. The

arrangement of subjects in order of fatiguability is: arithmetic; then, almost equally fatiguing, gymnastics and music; then language subjects; realistic subjects; lastly, and least fatiguing, the technical subjects.

As regards the length of lessons the results of fatigue measurements are comparatively clear. The length of lesson should vary with the age of the pupil; half-hour lessons are suggested for the youngest pupils, three quarters of an hour for eight-year-old pupils, and only with nine-year-old children the full hour. The length of the intervals in the work is dependent on the length of lesson periods. The recuperative effect of pauses decreases as fatigue increases; consequently the later intervals should be longer than the earlier ones. Through pauses a lack of adaptation or readiness for work occurs, and this to some extent counteracts the gain from recuperation, so that too frequent interruptions of work may not be ultimately beneficial. The intervals should be utilised for rest in the open air or free play, but not for gymnastic exercises.

Holidays and free afternoons have also an effect on the fatiguability of the pupils. Mondays and especially Tuesdays are the days of best work; efficiency diminishes on and after Wednesday, and some schools recognise this by making Wednesday afternoon a half-holiday.

On the value of the afternoon session the opinions derived from measurements of fatigue are not quite unanimous. The majority of writers, however, maintain that there is a considerable increase in fatigue in

the afternoon, and that the afternoon session is physically harmful and educationally valueless. After an interval of two hours at midday the recuperation of the scholars from a long morning's instruction is not complete. Offner contends[1] that the afternoon session, if it is not abandoned altogether, should begin not earlier than two hours after the noon meal, that is, at three o'clock and not at two o'clock. For schools under Government control in Britain we should suggest, in view of these results, that, for infants, afternoon sessions be abandoned; that, in the case of junior pupils, time in the forenoon session, in excess of that necessary to secure the attendance mark, should be allowed to compensate for a shorter afternoon session; and that permission be granted to give a weekly half-holiday on Wednesdays or Thursdays, and to substitute for this a Saturday morning session.

Recuperation is especially important for the hygiene of school work. Nothing is more effective in this connection than sleep, for which indeed there is no adequate substitute. Generally children between the ages of seven and nine require eleven hours sleep, ten- to thirteen-year-old children ten hours, and older pupils nine hours.

Change of work, it should be noted, even when that change is from mental to physical, is not rest. Both forms of work cause fatigue; and although there may apparently be a temporary increase in efficiency owing to the excitement induced by the change, fatigue nevertheless increases. This seems to be

[1] "Fatigue," English trans., p. 88.

contradicted by the common experience that after exacting mental work many individuals seek recuperation in physical games. The contradiction is, however, only apparent, since in games there may be no physical strain, and a direct recuperative effect may result from increased respiration and blood circulation, and the rapid removal of waste products caused by fatigue.

In the future, as the economy and technique of learning will demand that no child who is normally endowed should remain backward in school work, so will the mental hygiene of school work further require that no child will suffer, either temporarily or permanently, from over-pressure. That this ideal may be realised, further experiment on the lines indicated above is necessary.

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CHAPTER XIV

PSYCHOLOGY AND PEDAGOGY OF THE INSTRUMENTAL SUBJECTS

READING

IN proceeding to consider Reading we are entering upon that branch of Experimental Education which treats specifically of the methods of the various school subjects, and which we may term Experimental Didactic. Here, however, we shall confine ourselves to the consideration of the instrumental subjects, namely, reading, writing and orthography, and arithmetic.

The problem of reading is partly theoretical and psychological, partly practical and pedagogical. The main theoretical problem of instruction in reading is the psychological analysis of the act of reading, and the comparative analyses of the processes of reading performed by the child at various stages of practice and by the adult. The practical problem is to discover which method of learning to read, and consequently of instruction in reading, is most suitable for the child of five to seven years of age—that is, which method leads most quickly and most easily to correct, fluent, and expressive reading. The solution of the practical

problem depends on the theoretical or psychological analysis. We shall be in a position to choose the best method of instruction in reading when we know the partial processes involved, how these partial processes co-operate, and how fluent and correct as well as intelligent reading can be attained in the easiest and surest way.

As the value of the various methods of teaching to read can only be rightly estimated when we have a clear conception of the process of reading itself, it is necessary to consider briefly the general results of the purely psychological analysis. A consideration of the psychological analysis of reading has also the recommendation of impressing upon the teacher—with whom the act of reading has doubtless become so automatic as to be regarded as simple—the complexity of the reading process, and leading him to realise at how many points his instruction in the subject is liable to fail.

The psychological analysis of the reading process makes it at once evident that in reading there are three main factors, namely, (1) the meaning, (2) the expression of the meaning in speech, and (3) the visual representation of the spoken word. The first two are, or ought to be, closely associated in the mind of the child through practice or training in speech before he begins to read; we may consequently regard them as forming one division—the linguistic-ideational. The process of reading, then, consists of the task of associating the spoken word, and its meaning, with the visual symbol representing the word.

Any one of the three main processes—the visual,

[illegible]

The first reading method, which unfortunately dominated the elementary schools for centuries, was the alphabetic method.[2] In principle it consisted in learning the names of the individual letter characters and then combining these to form syllables and words. The chief mistake of the method was that the pupils did not learn directly the sound values of the single letters, but only the sound values of the letter names which contain, but incidentally, the sound values of

[1] Cf. case quoted in Welton, "The Psychology of Education," pp. [illegible]. For various forms of speech defects, see Leonard G. Guthrie, "Functional Nervous Disorders in Childhood," ch. xxi.

[2] For full account of method and criticism, see any work on elementary teaching, e.g., Welton, "Principles of Teaching," pp. [illegible], or Huey, "Psychology of Reading," pp. 254 and [illegible].

the letters; and out of the sound value of the name they had to discover, at considerable trouble, the sound value of the letter. The method has now no defenders. Of it Welton says:[1] "No child ever learned to read by that method: he learned in spite of it." And again,[2] "When the 'alphabet' method is followed by the teacher, the child learns just in so far as he disregards the teacher's method."

Along with the alphabetic method, the phonic method early appeared.[3] At first, however, owing to the prejudice of teachers, it obtained no great support. The phonic method and the phonetic method, which is a development of it, seek to make clear to the child the sound values of the letters, so that the visual character may thereby become associated with the sound of the isolated spoken letter. The phonic and phonetic methods are not without difficulty for the child. The sound of the word is not merely the sum of the sounds of the isolated elements, and the fusion of the latter into the complex sound is a source of difficulty. There is also the objection of burdening the child's mind with mnemo-technical material which later must be dropped from memory when the reading has become fluent.

The opposition between the alphabetic and the phonic or phonetic method may now be regarded as surmounted, since it centred on the mechanical effort of reading, namely, the building up of the association between the visual image of the word

[1] "Principles of Teaching," p. 115. [2] *Ibid.*, 116.

[3] In 1534, see Huey, p. 255.

and the vocal-motor process; the problem turns at present rather on the question how we may form in the child's mind the association between the visual representation of the word and its mental image or ideal content, and is expressed in the opposition between the analytic and synthetic methods. The mechanical part of reading is, however, also treated differently by these methods.

The analytic method proceeds generally from the whole word or even from the whole sentence, and the elements are, where possible, made known to the child only as components of the word and never in complete separation from it. The synthetic methods, on the other hand, begin either from the isolated elements or, even when they obtain these in the first place by analysis, they still dwell for a considerable time upon the treatment of the elements as such, and from these they build up single syllables, then words, and, lastly, groups of words. Neither of these methods can remain exclusively faithful to its first principle. Any intelligent form of the synthetic method proceeds from the pronunciation of the whole word, which is in turn resolved into its sounds, then for the first time are the single sounds connected with their visual signs: each form of the analytic method, after it has obtained the elements of the word from the linguistic and visual wholes, must likewise for a time dwell upon the establishment of the elements as such, and thereby it passes into a synthetic treatment. Instead of using the terms analytic and synthetic reading methods, it would be better on the whole, according to Meumann, to distinguish

them as methods which emphasise the isolated treatment of the elements, and, in opposition thereto, methods which lay the emphasis on using the word as a whole.

The older methods, the alphabetic as well as the phonic and phonetic, proceed in the main synthetically, as they make the child acquainted first with the elements and out of these require the syllables and words to be formed. In the word method[1] we have an illustration of the analytic treatment of reading; certain typical words are presented to the child as wholes; they are also written as wholes, and even the first observation lessons deal with the corresponding objects. The title under which the word method is best known in this country is the Look-and-Say method. The sentence method is another form of the analytic method where the sentence is taken as the unit.[2] To these analytic methods we must further add those which take as their starting-point the most important part of expressive reading, namely, the association of the visual form and the vocal expression with the meaning. Setting out from the psychological fact that the adult does not read single letters, but whole words or groups of words, and that the visual form of the letters and words does not represent the sound and meaning, but is only related thereto conventionally, one form of the method introduces reading to the child by getting him to draw in outline the forms of certain common objects and then to inscribe in these the equivalent words; for example, in an ellipse the

[1] See Huey, p. 272. [2] *Ibid.*, pp. 272–74.

word "egg" is written, and the child thus, after a fashion, reads the pictures. When the picture-reading becomes fluent the drawings which surround the script are dropped and the word is read by means of the written characters alone.

This is indeed a method of reading by heart and it taxes the memory to a greater extent than phonetic methods, in which only the associations between the fundamental sounds and the letter characters require to be remembered. With picture-reading the form of the word, the corresponding linguistic complex, the symbolised object, and the meaning must all be assimilated in the mind.

As to the value of the method, which is an extreme form of the word method, it must be admitted that it is based on a psychological fact, namely, that the adult reads by whole words and not by single letters, as is evident from the common overlooking of misprints. The question, however, arises whether we are justified in requiring the child to begin with the form of reading appropriate to the adult, or whether it would not be better to allow the child to adopt the method best suited to his stage of development, and leave to practice the task of training him to the reading method of the adult. The former consideration leads to the adoption of analytic methods, the latter to the synthetic.

It may be objected to the analytic methods above described that when children learn the words as wholes and become familiar with the elements—that is, the letters—only gradually and incidentally, they may not learn to read with sufficient correctness.

The investigations of Messmer at Zurich have demonstrated that children read in a highly assimilative manner; pupils of seven and eight years of age are prone to guess the context from a very few words and to see in the text only the words which they expect, and these they are inclined to falsify by reason of their subjective prepossessions. Children, indeed, assimilate the sight of the words so swiftly and so completely to their expectant ideas, that they frequently read words and groups of words which are not in the text. Synthetic methods of reading-instruction oppose this tendency, since they compel the child to proceed from the letters and to apprehend the elements of the words adequately, whereas analytic methods like the foregoing would seem to favour the tendency to subjective falsification.

That the word method has, however, certain recommendations cannot be denied. It saves the child the trouble of learning isolated sounds subsequently useless, and it dispenses with all the aids which the phonetic methods introduce to lighten the apprehension of the isolated sounds. Moreover, in the analytic methods the child employs elements familiar to him, since the spoken words with their meanings are known to him as wholes. Finally, the pupils are more likely to avoid a mechanical mode of reading, since they come to recognise the word as the representative of a meaning, not merely as a linguistic unit, and thus are early led to regard the word as a component of the sentence. It appears that children who learn to read by this method soon come to read with expres-

sion, although their reading is frequently inaccurate: they lack the grasp of the technical and mechanical factors.

The conclusion derived from a recent American investigation,[1] in which the words were learned as visual wholes, is that there is an undoubted advantage in having words presented at the start as units and wholes. But that a word method can be used very long without some detailed analysis of the structure and parts of the words is, it is maintained, altogether too common a notion in the theory, if not in the practice, of teaching.

A final judgment on the didactic value of the various methods cannot at present be given; this will only be possible when parallel groups of pupils, equal in age and intelligence, are instructed in accordance with the different methods and when the reading process of the child is analysed experimentally, so that the errors peculiar to one or other of the methods may be compared statistically.

We shall now turn to consider the experimental analyses of the reading of the adult and of the child, to see if these throw any light on the best method of instruction. The experimental treatment of reading has two aspects: one deals with continuous reading, and especially with the eye movements involved therein; the other with the single act of reading and with what can be read in the momentary exposure of words exhibited by means of the tachistoscope.

Various devices have been adopted to investigate

[1] Bowden, Josephine H., "Learning to Read," *The Elementary School Teacher*, vol. xii. p. 33.

and register the eye movements in reading.[1] The movements can be followed in a mirror or the more complicated arrangement of Huey may be employed.[2] In the latter the corneal surface of the eye was rendered insensitive with holocaine or cocaine and a small ring was fitted to the cornea; the subject was thus left free to read, but to the ring was attached a delicate lever, whereby the movements of the eye were transmitted to and recorded on a smoked drum, which rotated slowly.

The results of the observation of eye movements may be briefly recapitulated. The eyes in reading do not move regularly forward, but alternate between jerky movements and short rest pauses; the movement of the eye passes along the line of point and, according to Javal,[3] in such a manner that the fixation point does not travel along the middle of the letters, but along the upper part; the eye does not however, traverse the whole lines, but only their inner portion.

The fewest rest pauses in a line are one, the most about seven,[4] and the shortest adequate fixation pauses are between 70 and 100 thousandths of a second.[5] The more difficult the text, the greater the

[1] For these see Huey, "Psychology and Pedagogy of Reading," ch. ii.

[2] *Ibid.*, p. 25. For consideration of technique of recording eye movements see Dodge, R., "An Experimental Study of Visual Fixation," *Psych. Review*, Mon. Supp., vol. viii. pp. 79–95.

[3] *Cf.*, however, Huey, p. 27.

[4] See Huey, pp. 20–21.

[5] Dodge, *Psych. Review*, Mon. Supp., vol. viii. p. 48.

number of rest pauses made. A practised reader fixates a half, or a third, often even only a fifth, of the actual words. The fixation point lies frequently between two words, and from this it is evident to what extent the fixation of single words has become a matter of indifference in reading.

According to Dockeray's tests,[1] the average limen of clear vision for all letters on both sides of the fixation point was for his first subject 21·5 millimetres, for the second 22 millimetres, and for a third 20 millimetres, or less than an inch. According to Dearborn's results the greatest distance between fixations was 19·3 millimetres, and the least 9·65 millimetres. Huey found for two subjects that the average distance was 20·4. With a few exceptions the distance between fixations lies within the limen of distinct vision. This would seem to indicate that all that is read must come within the field of distinct vision in normal reading. In fact, it would appear that the fields of distinct vision for different fixations may overlap.

The reading process is not solely dependent on direct vision, that is, on what falls within the fovea centralis of the eye, but indirect vision, or what falls on the lateral parts of the eye, also assists the process. To determine the part played by indirect vision in reading, Meumann had spectacles so constructed that in reading with them subjects could see only with the fovea centralis, and lateral reading was completely excluded. Under such conditions it is found that subjects continually lose the lines and

[1] *Journal of Educational Psychology*, vol. i. pp. 123–31.

that the reading is of an exceedingly clumsy nature. The rate of reading is considerably retarded, yet it is noteworthy that even in this case a form of reading by letters does not make itself evident, but the subject tries to apprehend as large divisions of the words as possible, and to link these one to another. Indirect vision thus seems to have the task of guiding the eye along the lines. In proof-reading, misprints are sometimes noticed five or six lines ahead. From this it may be inferred that indirect vision gives us fleeting impressions of what is about to be read, and as it must likewise furnish images of what has already been read, it thus serves to make reading a continuous process.

The foregoing description deals mainly with the eye movements of the adult. The child who is taught according to a synthetic method follows with the eye letter after letter. He has no proper reading field, and therefore links single impressions to one another to build up from these the image of the word or the group of words which the adult apprehends at a glance.

The pedagogical conclusions[1] derived from the results of investigations on eye movements are that a more or less uniform habit of eye movemen should be acquired at the outset in reading, and that for this purpose shorter lines than those usually employed are necessary. Dr. Dearborn, although admitting that his data are not sufficient to warrant any conclusions upon this point, thinks favourably of a line of 75 to 85 millimetres, that is, about three

[1] Huey, pp. 44–46.

inches.[1] The length of the lines should be uniform, lest a cautious habit of eye movement, difficult to overcome, may be acquired and lead to slow reading. Many primers violate this principle of uniformity, breaking up the line with the illustrations and often making a paragraph, with its unequal lines, for every sentence. Dr. Dearborn and Professor Cattell both agree, however, that a small indentation of a few millimetres in every alternate line would help to differentiate the lines and prevent their confusion.

The single act of reading has been investigated mainly by the use of the tachistoscope. Two methods may be adopted. The time of the presentation of a word may be increased from a momentary exposure, when the subject fails to read it, to a period of exposure when it can be readily recognised and the time necessary for reading so determined; or momentary presentations only may be allowed, and the number of exposures necessary for the correct reading of the word registered, and the various misreadings that occur recorded. For the psychological analysis of reading the latter mode of procedure is the more valuable. The method of momentary exposures enables the act of reading to be resolved into its component parts, and thus permits of the isolation of what is visually apprehended from what is added by the assimilative factor in reading.

In tachistoscopic reading it has been observed that misprints are to a great extent overlooked. Thus in words of twelve or fourteen letters as many as eight letters can be altered, and the word is nevertheless

[1] The lines of the text are 85 millimetres.

read as if it were unchanged; the subject has also the impression that the whole word appears objectively in its correct form. Instead of "Hallucination," Zeitler wrote "Hallneiuotion," yet the word was read as "hallucination." It may be remarked in this connection that it is not a matter of indifference at what points in the word the wrong letters are placed, for the recognition of the word is conditioned by certain "dominating" letters which cannot easily be changed without the knowledge of the subject. In the recognition of the word, initial and final letters are, according to Zeitler and Huey, the dominating factors; then come long letters above the line, then the letters extending below the line, and lastly medium length letters. Miss Bowden,[1] who classifies words into linear—those with medium length letters only, for example, "were"; super-linear, for example, "child"; sublinear, for example, "going"; and super- and sub-linear—like "dog," found, however, that of six children tested four learned more of the linear words than of the other groups, and that in only one case were super-linear words, which Messmer holds to be more easily recognised, learned more readily than those of any other group. The upper half of the word is also more important for recognition than the lower, the left half more important than the right. This is easily tested by covering the upper half, then the lower half of a word; in the former case the word is practically illegible, whereas in the latter it is easily recognisable.

The visual articulation is, however, as Messmer was the first to point out, the most important factor in

[1] "Learning to Read," p. 28.

determining recognition. If we compare a word like "consciousness" with "individuality" it is at once evident that the former word appears only as a broad uniform streak or band, whereas the latter presents a definite visual contour, resulting from the alternation between the long letters and the medium length letters. The form of the visual articulation serves as the most important factor in the recognition of the word, and the reading of the adult probably consists exclusively in the rapid apprehension of this characteristic. It suffices in the case of the relatively practised reader to reproduce the whole of the word, the visual image, its sound value, and the meaning. With children, according to Miss Bowden,[1] the length of the word is the most important feature. Recognition of words turned upside down was also found by Miss Bowden to be less difficult than recognition of words in which there was substitution or transposition of letters. According to statements made by the children the inverted forms appeared exactly the same as the words were before they were inverted.

Any simplifications of orthography tending to eliminate the individual peculiarities and eccentricities in words would, it has been suggested, hinder recognition and cause reading to be slower. Accordingly, we find Professor Münsterberg protesting that "the written image may tell us much which seems logically superfluous, since it brings out elements of the word that cannot be pronounced, and which phonetic spelling seeks to

[1] "Learning to Read," p. 29.

abolish. But just as well might we propose to close one's eye in reading, for the reason that the nervous processes in the second open eye and in the corresponding half of the brain are a shameful waste of neuron-activity. Indeed, we can read 'just as well' with one eye and hear with one ear; and yet nature knew better: this luxury is economy. Give us as many optical hints for the discrimination of the words as possible, and the more we apparently waste the more we save. Simplicity and uniformity are the only real waste, because they demand from us an amount of attention which is ruinous in its cumulation; they perhaps reduce the expense for printer's ink; but they increase neurasthenia among the millions of newspaper readers."[1]

The results of the above-mentioned investigations enable us to answer more easily the question whether the adult reads by letters. In the case of a relatively practised adult, reading by letters no longer exists: in one act of apprehension the total impression of a word or group of words is obtained. The facts supporting this statement are based on the oversight of misprints and of omissions of parts of words or short words in reading; the alteration of words in accordance with the conjectured sense, or "misreading"; the possibility of the substitution of letters leaving the form of the word unaffected; reaction time tests which demonstrate that the reading of single words takes practically the same time as the reading of a single letter, and that the

[1] "Problems of To-day from the Point of View of a Psychologist," p. 202.

time required for the recognition of single words is appreciably longer if the words are read in isolation than if read in sentences.

From the tachistoscopic experiments we learn that as visual apprehension is very fleeting, abundant opportunity is afforded for reading into the context what is conjectured. The adult consequently reads in a construing manner, assimilating the text to the expected words rather than attempting to obtain an objectively true apprehension of them. The interpretation in most cases fits the text, whereas with children the assimilative factor and the visual impression do not coincide, and the child consequently appears to be a more subjective and conjectural reader than the adult.

The investigations also disclose individual differences, on the basis of which a classification into "reading types," that is, types of readers, is possible.[1]

(i.) We can distinguish the rapid from the slow reader. The rapid reader reads both nonsense material and intelligible material more quickly than the slow reader, and he likewise apprehends the sense more quickly. With adults these differences in the rate of reading are very considerable, but it is not yet known on what they depend; the differences are only to a small degree eliminated by practice.

(ii.) The hesitant reader has also been distinguished from the fluent. Even with cultured and well-practised adults Meumann found readers of surprising

[1] *Cf.* Whipple, "Manual of Mental and Physical Tests," p. 241.

hesitancy who could not read aloud fluently without repeated hesitations. With such, attention may be so centred on the apprehension of the sense that the vocal-motor innervations may be inhibited.

(iii.) There is also the difference between the typical misreader, or subjective reader, and the objectively true reader, but this difference perhaps coincides with the important fourth type, namely, the fluctuating and the fixating readers.

(iv.) These two types, the fluctuating and the fixating, are distinguished by the following differences in their manner of reading long words in tachistoscopic tests with momentary exposures. A reader of the fixating type reads at the first exposure a small definite part of the word lying in the direction of the fixation point, observing nothing of the remainder of the word; when the exposure is repeated he adds a definite continuation of the parts of the word lying on either side. This type of reader is seldom induced to complete the partially apprehended word by guessing. Thus a reader of the fixating type read as follows in four consecutive presentations of the word "characterization":—[1]

(1) . . z . . . ation
(2) . . . . zation
(3) . . . rization
(4) characterization.

[1] Examples from article, "Über Aufmerksamkeitsumfang und Zahlauffassung," by F. W. Freeman in *Pädagogisch-psychologische Arbeiten*, vol. i. pp. 116, 119.

A reader of the fluctuating type proceeds quite differently. He notices, sometimes even at the first reading, letters which stand at the extreme left and extreme right, along with certain others in the middle of the word; these parts he combines, by guessing, into the word conjectured. Thus, a reader of this type read as follows in consecutive presentations of "characterization":—

(1) ch..et...r.z..t..i..a
(2) characteri .. tion
(3) characterizianum
(4) characterization.

From this it is evident that the word as a whole is read from the first in a series of guesses.

The reader of the fixating class can as a rule specify exactly the part of the word fixated: the fluctuating reader is under the impression that he apprehends at once the whole word. If the former has not at the outset chosen the correct fixation point, he fails to recognise the word at all: his attention is centred on the optical fixation point and shifts as the visual fixation alters. His range of attention is circumscribed: of unrelated letters, in momentary exposure he reads but three; and of intelligible material, words of twelve letters, or even of as many as fifteen letters, if the words are familiar to him. His attention is directed outwards and is in this sense "objective." The reading of the fixating type is characterised by objective fidelity and is also objective in the sense that it is not supplemented by guessing. With the reader of this type, a distinct

time interval elapses between the visual apprehension and the assimilative interpretation or meaning of the word, and he can definitely distinguish the two factors.

The reading of the fluctuating type has just the opposite characteristics. A reader of this type cannot specify the fixation point; his attention is not directed to the place of fixation but wanders over the word and has an extensive range, apprehending at a glance five nonsense characters or words of twenty-seven or more letters. The detachment of the attention from the fixation point is clearly demonstrated by the fact that a representative of this type can read words in indirect vision, whereas the fixating reader cannot do so. The fluctuating reader almost invariably reads whole words, seldom parts of words; he is unable to distinguish between objective perception and subjective additions: his reading is mainly a matter of guessing, and no interval appears between the visual act and the mental apprehension. His attention is directed not outwards, but inwards; he does not analyse the word presented, but analyses his own mental content to discover a word wherewith to interpret the fleetingly apprehended impression. He is therefore a "subjective" reader.

These two types do not probably coincide with the slow and rapid readers, as there are fluctuating readers who read relatively slowly, and readers of the fixating type whose reading is relatively rapid.

So far, we have considered the reading of the adult. The question arises, How does the reading of

the child proceed in these respects? To answer this question, we must distinguish between the reading of the relatively practised child and that of the beginner.

With good readers of the elementary school, reading by letters disappears before the eleventh year, thus indicating that the method of the child passes early to that of the adult. The reading of the most practised children, nevertheless, displays certain distinguishing features. According to Messmer all relatively practised children are of the fluctuating or subjective type; they display an inadequate observation of the visual characters. And the limited vocabulary which the child has at his command intensifies this subjective tendency. It is not, as with the adult, that his attention is directed to the meanings of the words. In opposition to Messmer's view, that all children are fluctuating readers, Meumann declares that he has repeatedly found children of a pronounced fixating type. In this difference between fixating and fluctuating attention we seem to have a fundamental difference of intellectual endowment which holds even in the case of the child, although, for the reasons given above, the distinction is not so noticeable as with adults. In general, however, with the child the apperceptive and assimilative type of reading preponderates over the apprehensional and observational.

The reading of the beginner, taught according to synthetic methods, differs from that of the adult in that it is a form of reading by letters. Whereas the adult reads a total word-form that is

apprehended in one psychical act, the child must apprehend visually each letter separately, find the isolated sound values for each, and also perform the various motor acts of pronouncing them; the reading of words is only possible through the fusion of these isolated psychical processes by the child. At the outset, then, the child reads synthetically, whereas the adult, in a certain sense, reads analytically; or, rather, the adult has not to analyse because he reads total word-forms. The main difference, however, is psychical: the beginner requires for the reading of a word as many separate innervations as there are letters—each letter requires a separate innervation to apprehend and express it—but with one general innervation the adult apprehends and pronounces whole words or groups of words.

Children taught according to the word method, as was the case in Miss Bowden's investigation, seem to learn to read words by the trial and error method. In her investigation there were surprisingly few instances of learning by imitation.

From the foregoing analysis it is evident that analytic methods of teaching the child to read will more quickly than synthetic methods attain the end of instruction, namely, the reading method of the adult, that is, reading by word wholes. Such a form of reading can doubtless be secured by practice alone, but practice does not guarantee an exact assimilation of the elements of the words; to attain this, synthetic methods, although slower, are necessary.

From the results of certain tests, Meumann gives the preference to synthetic methods, with the qualifi-

cation that, as the acoustic-motor process requires special assimilation, the synthetic method should be preceded by an acoustic and linguistic analysis of the words. The correct system, according to Meumann, seems to consist in a combination of both methods. The teaching should commence with detailed exercises in the acoustic analyses of the words, supported by phonetic instruction; this acoustic analysis should be accompanied by a parallel visual analysis of the word form; the synthetic method should then be applied with an adequacy and thoroughness such as would have been sought if the analytic methods had not preceded it. Miss Bowden's conclusion, although the investigation was conducted with children taught according to the word method, is to the same effect.

The relation of the spoken word to the meaning must also be considered. Advantage should be taken of connections already existing and, consequently, the choice of words should be determined not solely by their simplicity, but also by the fact that they convey self-evident ideas; we should, according to Meumann, begin, then, with concrete nouns whose content in the form of independent images is evident to the child. Miss Bowden also found that the content of the word and its use in the sentence are factors which influence the ease with which it is learned, nouns and adjectives appearing to be more easily learned than other parts of speech.

The question whether script or print is the more easily read by children is worthy of mention. From

the results of investigations carried on at the University of Chicago and reported by Miss Bowden, it appears that almost from the first the pupils could match the word in script with the printed word and *vice-versa*. To the child the script is evidently merely another form of print.[1]

Thus far, we have been concerned mainly with the single act of reading; the same principles, however, apply generally to continuous reading. With one innervation the adult can read a group of words, whereas the child requires a separate innervation for each. For a group of words the practised reader, too, only requires a slight stimulus from the dominating letters or visual articulation of the words; as his attention is not concentrated on single letters, his reading field is continually extending, and indirect vision consequently plays a greater part in his reading than in the reading of the beginner. The apperceptive guidance in reading is also greater with the adult.

The knowledge which we have gained by the analysis of the act of reading may furnish some suggestion as to the treatment of individual children in the teaching of reading. It is easy, for example, to observe the bearing of the distinction between the fluctuating and fixating types of attention on the method of instruction in reading. Children with strong fluctuating tendencies should be practised in fixation of attention and exact observation; for exceptionally weak readers of this type formal exercises with the tachistoscope have even been suggested.

[1] "Learning to Read," p. 31.

It is more difficult to provide for the imagery types in reading instruction. The entire process of reading may possibly be different with children of the visual type from what it is with the auditory and motor. The main difference between the visual and the auditory reading types lies in this; for visualisers the meanings of words are aroused directly at the sight of the words, and the linguistic or acoustic-motor images operate, at most, as secondary factors, whereas for audiles the meaning is first aroused by the sound image. From our present knowledge of the imagery types, it seems highly improbable that a visual type of verbal imagery exists in such a pronounced degree that the sound images are superfluous for obtaining the meaning of the word: it is rather the case, with the great majority of visualisers, that when they think of a word, acoustic-motor images also operate, and all unpractised readers, and more especially unpractised children, are assisted in reading by silent speaking. Meumann regards purely visual reading as an extreme case which can exist only with very practised adults. Consequently specialisation in reading instruction for imagery types is not demanded by our analysis.

Many children on commencing to read from books become confused by the number of visual stimuli, lose the line, and consequently the word. Our analysis has shown that it is the function of indirect vision to guide the eye over the line, and that the child's field of vision, and consequently of indirect vision, is limited. To assist the child in keeping the line, a reading slide has been recommended; it

consists of a card with aperture which leaves only one line open to view. The distracting stimuli from other lines are thus excluded and the child is enabled to concentrate on the word read. The slide is moved along the line as the child reads, and the aperture can be gradually increased in length and breadth until its aid becomes unnecessary.

A point to be experimentally decided is, whether for oral reading the sense of the passage should be made known previously: this, it seems, ought to be done by conversation; otherwise the bungling of the pupil may create a disgust at the sense of the text.

The rate at which instruction should proceed also requires experimental determination. Generally a slow advance is to be recommended, because the elements are thus more accurately apprehended and the assimilation of the partial processes is developed with thoroughness and precision.

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CHAPTER XV

PSYCHOLOGY AND PEDAGOGY OF THE INSTRUMENTAL SUBJECTS

HANDWRITING

IN the past the teacher's judgment as to the value of various styles of writing, or of various specimens of the same style, has been merely a matter of personal preference, and his knowledge of the psychological processes involved has been negligible. Recently, however, attempts have been made to standardise the different types of writing and also to analyse and evaluate the factors in the writing process.

Amongst the practical problems which Meumann considers adapted to experimental treatment the following may be enumerated: Should learning to write be pursued simultaneously with learning to read? Should a beginning be made with writing itself, or should it be preceded by simple drawing, in order that the child may first acquire manual dexterity, visual precision, and understanding of forms? Pestalozzi, it may be mentioned, considered writing a part of instruction in drawing. The question arises, Should we adopt analytic or synthetic methods?

The word-writing or sentence-writing method proceeds analytically, requiring a group of words or a single word to be written as a whole, and passing later to the treatment of the elements, that is, to letters and their characteristic features. Contrariwise, the synthetic method starts with the characteristic elements of the letters, then proceeds to the letters themselves, and finally to syllables and words. There are, moreover, numerous technical questions involved, such as the relative merits of vertical and sloping writing; the position of the writing-copy, the body, and the fingers; the value of copy-setting, transcription, dictation, and choice of writing material.

The problems with the determination of which psychological investigation has so far mainly concerned itself include the amount of hand-pressure involved; the nature of motor innervation, with special reference to the question whether the act of writing is produced by particular impulses or by a totality of impulses; speed of writing and the relative time occupied in the execution of the single letters and parts of letters; the influence of mental preparation for writing, that is, what difference results if we write from memory, from dictation, or from a copy; the nature of the eye-movements; and certain subsidiary processes, such as the influence of writing to a beat.

The best point of departure for the psychological analysis of the process lies in the consideration of handwriting itself. It is well known that most individuals have an individual style which can be recog-

nised even from a written address. The handwriting of others presents no individual characteristics, but it is possible to recognise in their handwriting the style of copy from which they were taught. Preyer has accordingly distinguished between natural and artificial handwritings. In artificial handwriting the copy set is so closely imitated that individual peculiarities wholly, or almost wholly, disappear. The natural handwriting is that in which the letters, and even their mode of connection, are formed in an individual fashion peculiar to the writer.

Preyer supposed that the handwriting of the child was artificial, and that it showed no individual character. This, however, is but partially true. The handwriting of the child depends more on the copy than does that of the adult, but teachers, especially of the highest classes, can readily recognise the writing of individual pupils. Ufer has more truthfully remarked that the handwriting of the child occupies an intermediate position between the natural and the artificial, and with the increasing age of the child gradually approximates to the natural type. He has sought to bring the peculiarities of children's handwriting under ten heads: unnecessary additions, for example, flourishes at the beginning or end of the word; angles in place of curves and *vice versa*; differences in slope; connection of letters one with another—with young children a complete separation between letters does not appear to exist; spacing of writing characters; distance between single words; absolute size of the single letters; relative sizes of

letters and parts of letters; observance of lines; form and position of the auxiliary signs like the dot on the "i." We may conclude from this enumeration that, if these peculiarities are discernible in the writing of the child, we can speak of individual handwriting of children. Ufer has failed to include difference in hand-pressure and in speed, which likewise present individual peculiarities.

A further consideration of the writing of adults discloses typical sex differences.[1] From the judgments of different individuals on two hundred addressed envelopes, Miss Downey concludes that it is possible to determine sex in perhaps eighty cases out of a hundred.

Originality is held to characterise the man's hand, conventionality the woman's. Consequently masculine handwriting is thought to show a more extensive range of variability than feminine. The typical feminine hand appears to be colourless, conventional, and usually small. The typical man's hand is bold or careless or experienced, and, above all, individual.[2] A study of the cases showing inversions of judgments, for example, where a man's handwriting is regarded as belonging to the feminine type, leads to the belief that the presence or the absence of the so-called sex-signs is, in the case of any one writer, influenced largely by (1) the amount of writing done, (2) age, and consequently, to a large extent, practice, (3) professional requirements, such as are shown by

[1] Downey, June E., "Judgments on the Sex of Handwriting," *The Psychological Review*, vol. xvii.

[2] *Ibid.*, p. 209.

the conventional writing of grade teachers and the rapid hand of book-keepers.[1]

Experiments on unconscious imitation in handwriting demonstrate a greater imitative tendency among women than among men.[2]

Psychological experiments on the distribution of pressure in handwriting[3] have disclosed corresponding types. In the case of adults, two types of writing are clearly distinguishable, characterised respectively as the masculine and the feminine type. The masculine type writes with more pressure than the feminine, somewhat more slowly, and more completely in total impulses. The pressure is rhythmically distributed over the word so that generally the highest or maximum pressure lies at a definite point in each word. Some individuals place this maximum at the beginning, others at the end of the word. It is a special characteristic of the masculine type that the pressure increases with the speed. The feminine type, to which, however, the writing of some men conforms, writes more quickly than the masculine,[4] but with less pressure and not in such uniform total impulses. The pressure

[1] Downey, June E., "Judgments on the Sex of Handwriting," *The Psychological Review*, vol. xvii. p. 211.

[2] Starch, Daniel, "Unconscious Imitation in Handwriting," *Psychological Monographs*, vol. viii. pp. 301–34.

[3] For account of procedure and apparatus suitable for determining such, see Freeman, "Preliminary Experiments on Writing Reactions," *Psychological Review*, vol. vii., pp. 301–34.

[4] Confirmed by Burt, C., *Journal of Experimental Pedagogy*, vol. i. p. 111.

curve has in most cases several maxima, and it is characteristic of this type that with increased speed pressure decreases.

The writing of the child is quite different. Here, as with reading, the beginner has to be distinguished from the more practised pupil. The latter in his style of writing approximates more or less to the type of the adult: the writing of the beginner, on the contrary, presents radical differences from that of adults. With children of six and seven years a pressure maximum is never found in the word, but each single letter, and at the outset each single stroke, is written with equal pressure. With such children no rhythmical writing curves can be obtained, but only an extraordinary long-drawn-out curve, which remains about the same height for each stroke. The highest point of pressure attained in a word is at the same time less than with the adult. The comparative rates of writing are likewise different: the adult writes the single letters of the word according to a definite temporal rhythm, so that at one place in the word, and at definite places in the various letters, an increased rate of writing occurs, whereas the child generally writes more slowly and produces each stroke at approximately the same rate.

The movements made in handwriting have been the subject of investigation.[1] McAllister required writing movements to be made under certain con-

[1] McAllister, Cloyd N., "Researches on Movements used in Writing," Studies from the Yale Psychological Laboratory, vol. viii. pp. 21–63.

ditions and at certain angles, and determined their degree of difficulty by the time taken. If the movements in the first quadrant of a circle, that is, between 0° and 90°, are taken as the standard, movements in the second quadrant, that is, between 90° and 180°, are found to require 30 per cent. more time, movements in the third quadrant 10 per cent. less, and movements in the fourth quadrant 25 per cent. more, than the standard. These measurements reveal at least one valid objection to "backhand" writing, namely, that such a slope entails movements comparatively difficult to perform, and thus reduces the speed to such an extent as to make this form of writing inadvisable.[1]

The movements made in writing include those of the fingers in forming the letters, of the arm across the page, and the movement of pronation, that is, the rotation of the hand so that it may rest flat on the palm.[2] McAllister has found[3] that the full-arm movement with the elbow resting on the desk is much more rapid than the finger-and-wrist movement. The latter permits of round forms and therefore a more legible hand; it is much slower than the full-arm movement, requiring at least 16 per cent. more time than the latter, so that the loss of speed doubtless neutralises any gain in

[1] McAllister, Cloyd N., "Researches on Movements used in Writing," Studies from the Yale Psychological Laboratory, vol. viii. p. 63.

[2] *Cf.* Judd, C. H., "Genetic Psychology for Teachers," ch. vi.

[3] *Studies from the Yale Psychological Laboratory*, vol. viii. p. 53.

legibility. Experience shows that neither movement should be used exclusively; the freedom of the fore-arm, united with the more delicate touch and shaping power of the fingers, enables the pupil to write easily and rapidly with a minimum of fatigue.

In the case of young children most attention should be given to developing a good full-arm movement. Even thus the fingers will be largely employed. The elbow should, of course, rest upon the desk. All the larger movements and also the strokes should be made with the full arm. The fingers should aid in forming the turns, thereby producing wider curves than could be produced by the full-arm movements alone.

The preliminary training of the child should, according to McAllister, aim at perfect control of the hand. Clay modelling in the kindergarten is useful for this purpose, and this should be accompanied by training in the use of the brush. Most children have the slate or lead pencil placed in their hands first. These require a firm grip and some pressure in order to produce sufficient friction to make visible the path of the point. The habit thus formed of gripping the pencil is difficult to eradicate. The broader path of the brush renders a small figure or character impossible for the little hands, and a large full-arm movement is readily acquired. By the continued use of the brush a higher degree of muscular sensitiveness is gained and the child soon learns to make finer and more regular lines. No attempt should, be made to form letters with the brush: care should, however, be taken that the forms of the letters are

otherwise properly impressed upon the mind of the child. The use of the pen will follow naturally upon this. The brush does not require a tight grip, and the pen will consequently be held lightly. Soft pens and light penholders should be used. Attention should be given to the manner of holding the pen; the wrist or side of the palm must not rest upon the table; the third and fourth fingers should support the hand. The ink should be a heavy black or dark blue, and the paper a light yellow.

McAllister also concludes[1] that the letters should be considerably smaller than the large copies at present placed before beginners. He recommends that after the forms of the letters have been thoroughly mastered, each pupil should be allowed to adopt the size naturally agreeable to himself. The space between the lines should be sufficient to prevent any appearance of crowding, and to permit of paying no attention to the lines. The hand usually acquires a slope that is farther removed from the perpendicular than the copy, a child generally deviating about 10° from the vertical. McAllister consequently suggests that for the beginner the slope should be 90°, and that the paper be placed in front of the child, the left edge on, or a little to the left of, the median line. This permits the child to follow the pen more easily with the eye.

The question of the analysis of handwriting has

[1] McAllister, Cloyd N, "Researches on Movements used in Writing," *Studies from the Yale Psychological Laboratory*, vol. viii. p. 62.

recently been reconsidered by Freeman.[1] In regard to the proper slope of writing he argues that the most natural direction for a downward stroke is toward the body, that is, in a line perpendicular to the edge of the desk when the writer sits facing it. This would result in vertical writing if the paper were placed parallel to the edge of the desk. The other factor determining the slant of the writing is the direction of the easiest movement of the arm in carrying the hand along the line. The easiest movement cannot be made with the paper parallel to the edge of the desk, for this involves drawing back the arm in order to avoid running off the line. To secure the easiest movement, it is necessary that the paper be tilted to the left so that the base line of writing is about perpendicular to the forearm. If the paper is inclined to the right, the writing will be inclined to the right in the same degree.

Theoretically, vertical writing has the advantage over sloping writing in legibility; but this advantage is not, according to Freeman, maintained in practice, the degree of legibility depending largely on whether or not the writing conforms to the conditions necessary for ease and rapidity of movement. The practice of teaching writing with a moderate degree of slant seems therefore to be justified by psychological analysis.[2]

The opposition between analytic and synthetic

[1] Freeman, Frank N. "Some Issues in the Teaching of Handwriting," *The Elementary School Teacher*, vol. xii. pp. 1–7, 53–59.

[2] *Ibid.*, p. 4.

methods resolves itself in practice into the question as to which component should be developed first, correct movement or form. Freeman concludes that strenuous movement drill should be deferred for three or four years, attention being first concentrated on the correct form.[1]

Meumann maintains that the synthetic methods of teaching handwriting are of more didactic value than the analytic, since with the emphasis of the former upon the elements a more exact appropriation can be guaranteed: the synthetic methods, too, do not cause any delay in the formation of total innervations, which are acquired soon enough by continuous practice.

Where the synthetic method is adopted, Freeman advocates[2] that the letter, and not the "elements of the letter," should be regarded as the unit. But he believes that it is hardly necessary to use the letter or the word method exclusively. If words are used as the main basis, then this procedure may be supplemented by the introduction of drill upon the letters whenever this seems to be necessary to remedy defects which may be found, or systematic drill upon the letters may be used to supplement the writing of words.

From his psychological analysis of the writing movement Freeman concludes[3] that the most favourable type of movement is one which combines the

[1] Freeman, Frank N. "Some Issues in the Teaching of Handwriting," *The Elementary School Teacher*, vol. xii. p. 7.

[2] *Ibid.*, p. 54.

[3] *Ibid.*, p. 59.

use of the arm, of the wrist, and of the fingers, in such a way that each does the work for which it is best adapted. In general, the best condition for an efficient movement is one in which the various joints are not held in a rigid position, but in which there is such flexibility that there may be smooth and harmonious co-operation between the joints.

Investigations have been made with children to determine the effect of writing to the beat of a metronome. Writing thus, children display fewer separate impulses than when writing without the beat. The compulsion to rhythmical writing thereby induced causes the child's writing artificially to approximate to that of the adult. Writing to a beat has on the whole a marked influence on handwriting; generally under the influence of the beat the child writes more rapidly, but the writing is not so uniform. It is consequently important that the *tempo* of writing to the beat should not be made too quick. With young children this *tempo* is very much slower than with adults.

The relative times of writing have been investigated with the aid of special apparatus. Such investigations have shown that the influence of the mental preparation is very great with children as it is with adults. If we compare the operation of writing the figures 1 to 9 forwards with that of writing them backwards, the latter operation is found to be performed more slowly and more pressure is exerted. The less familiar association requires a greater concentration of attention, and this causes a greater pressure and a certain retardation in

writing. This mental preparation in children comes especially into prominence when we consider whether children should write from a set copy, from dictation, or from memory. They write better from a set copy, at more regular speed, with greater uniformity of pressure, and form the characters better; but as soon as children become expert, the copy has an inhibitive effect and writing to dictation gives more favourable results. All these circumstances naturally react on the appearance and form. Generally we may say that irregular distribution of pressure, retardation and irregularity in the relative times accompany a deterioration in the form of writing.

Thorndike has investigated writing on its objective side and sought to establish a graphometer or scale[1] by means of which the quality of a specimen of handwriting may be estimated and valued with comparative accuracy.

The scale which Thorndike presents is the result of some twenty thousand ratings by competent judges. The degrees of difference in the scale are equal in the sense of being called equal by such judges. Zero merit is defined roughly as a handwriting just recognisable as such, but of absolutely no merit. Quality 18, the highest grade, consists of a copy-book model. The scale thus extends

[1] Thorndike, E. L., "Handwriting," *Teachers' College Record*, vol. xi. No. 2. For method of constructing scale see pp. 4–8 and 39–45; and for illustration of scale pp. 9–37, or Thompson's "Psychology and Pedagogy of Writing," pp. 105–12.

from a quality beyond the reach of any pupil to one so bad as to be seldom, if ever, found in school practice. The scale includes specimens of as many different styles as could be obtained, so that the merit of any style of writing can be readily ascertained by comparison with the scale.

Amongst the advantages claimed for the use of the scale Thorndike suggests that, in order to assign to a pupil a value in comparison with his fellows or in comparison with his own past performances, a teacher may use the scale either by giving its numerical measures outright or by indicating the relationship to the scale of such other equivalents, as A, B, C, or 80, 75, etc., per cents., or excellents, goods, fairs, etc.; in this way the values will have not only a definite meaning to the pupil, but also the same meaning as similar ratings by other teachers in the school, and thus indicate the actual improvement month by month and year by year. The relative values of different methods of teaching, of different periods of practice, and the like, may thus be measured. A principal or superintendent of schools can by this scale compare the method of one teacher with that of another, the work within his own school or city with that of other schools or cities, and with that of his own city several years earlier. The pupil himself may profitably know and use the scale, seeing by it what is expected of him and how nearly he approximates to the recognised standard.

By the application of the scale to several different school systems, Thorndike found that at least three

systems, devoting about seventy-five minutes a week to writing, get results no better than those obtained by two systems devoting no time to it, and that another system giving the former time gets results about 25 per cent. better than the three first mentioned. On the whole, he concludes,[1] efficiency in handwriting seems under present conditions to be not very much influenced by the management of the schools. Considering the differences between individuals within the same school system, he suggests[2] that rapidity is in itself a good sign. If we know nothing about a score or so of pupils save that they are rapid writers, and nothing about another score save that they are slow writers, we can prophesy that at the same rate the former group will on the average do writing of a higher quality.

Comparing, with the help of the scale, the writing of two higher classes of a school with the average writing of adult women teachers, Thorndike is led to advocate the heresy that children are taught to write too well. The time spent in acquiring the highest qualities of handwriting would, he argues, much more than suffice to enable the pupil to type, almost perfectly, at the same rate.

Thorndike has also sought to determine the degree of correlation in the case of adult women students between ability in handwriting and general intellectual ability. Gesell has claimed that with

[1] Thorndike, E. L., "Handwriting," *Teachers' College Record*, vol. xi. No. 2, p. 74.

[2] *Ibid.*, p. 76.

children there is a high positive correlation between quality of handwriting and intellectual ability; but Thorndike's results show that the correlation between scholarship grade and quality of handwriting is zero.

Speed of writing, however, correlates with general ability as highly as the best of the sensori-motor tests used by Burt in his investigations on General Intelligence.[1]

ORTHOGRAPHY.

The first attempts to apply experimental methods to the teaching of Orthography we owe to Lay, who sought to demonstrate the significance of speech and writing movements therein. His researches have been developed by Fuchs and Haggenmüller at Giessen, by Itschner at Jena, and Lobsien at Kiel.

In the learning of orthography the following are the most important factors involved: (1) the correct hearing of the word, (2) the correct speaking of the word, (3) the visual appearance of the word, (4) the writing movement. The points of departure for method are, respectively, the acoustic analysis of the word, the correct pronunciation of the whole word and of the constituent sounds, the visual apprehension of the written word, and the writing of the word, which can take the form of writing in the air, that is, drawing the letter

[1] Burt, C., "Experimental Tests of Higher Mental Processes and their Relation to General Intelligence," *Journal of Experimental Pedagogy*, vol. i. p. 98.

forms in the air with the finger, or writing on paper. All possible combinations of these factors are conceivable.

The methods employed in school practice illustrate these. One method attempts to secure the correct reproduction of the word mainly through sounding the letters—here the emphasis is on the verbal sounds and the vocal movements; another method depends on dictation, in which the emphasis is on the verbal sounds which are merely heard or are accompanied by the uncontrolled speech movements of the child. Again, reading may be used as a method for learning orthography, the emphasis here being on the visual form, with verbal sounds and vocal movements as secondary accompaniments; or, lastly, transcription may be employed, in which case the emphasis is laid on the visual form and on the grapho-motor sensations and imagery.

Lay proceeded to subject these various methods of school practice to a comparative experimental test. His first task was to secure material of uniform difficulty in order that the comparative tests might be performed with words of similar articulation and visual form. This condition can be attained only approximately with intelligible material, the meanings of the words tending to influence the results. Lay consequently adopted unintelligible or nonsense material, so arranged that in each successive series the consonants remained the same, the vowels only being changed; thus, for example :—

Libug, Bollis, Gohlin.
Labog, Bulles, Gihlin.

This method, nevertheless, favours visual presentation and prejudices auditory presentation.

The series were arranged as follows:—

I. Writing after merely hearing the words, *i.e.*, to dictation.
  (*a*) Hearing without vocalising: the children were required to keep the jaws closed, which is, however, but an imperfect means of suppressing vocalising.
  (*b*) Hearing with speaking in an undertone.
  (*c*) Hearing with speaking aloud.

II. Writing after seeing.
  (*a*) Seeing without vocalising.
  (*b*) Seeing with speaking in an undertone.
  (*c*) Seeing with speaking aloud.

III. Spelling the letters aloud.

IV. Transcription.

The main tests included 100 class experiments on each of thirty pupils from the first to the sixth school year, in all 3,000 tests. They were further applied to students in training, yielding about 1,800 single tests.

The number of errors was calculated and the value of the methods thereby determined.

The results showed that mistakes were distributed as follows:—

Hearing without vocalising	3·04	per scholar
Hearing with speaking in an undertone	2·69	" "
Hearing with speaking aloud	2·25	" "
Seeing without vocalising	1·22	" "
Seeing with speaking in an undertone	1·02	" "
Seeing with speaking aloud	0·95	" "
Spelling aloud	1·02	" "
Transcription	0·54	" "

Thus for the learning of orthography transcription and seeing with speaking aloud give the best results. Then quite surprisingly comes the much maligned spelling of the letters aloud ; thereafter, seeing without vocalisation, and, lastly, hearing without vocalising.

The tests of Fuchs and Haggenmüller were carried out in the third class of an elementary school and the corresponding class of the Gymnasium at Giessen. The material consisted of Latin words, the meanings of which were unknown to the scholars. To the exercises of Lay, Fuchs and Haggenmüller added writing in the air with seeing and with hearing. Fuchs, however, concludes from the results of their experiments that vocalising and imaginary writing are not valuable methods, since the errors are comparatively numerous. This ineffectiveness of imaginary writing demonstrates clearly that it is not the writing movements in themselves which aid correct spelling, but the combination of the writing movements with the visual apprehension of the word. The value of the writing movements consists merely in securing visual and mental analysis of the forms of the words, and in compelling the attention to linger on the different written characters ; they thereby effect a more fundamental analysis and ensure a more lengthened impressing of the word on the mind than is possible when the word is only fleetingly heard. The addition of the grapho-motor imagery to visual imagery is then of only secondary significance.

Itschner's tests at the Seminar school at Jena included intelligible and also non-intelligible words ;

but, according to Meumann, they are not numerous enough to lead to valid conclusions.

The following objections have been urged against the methods indicated. In Lay's test the number of repetitions with elementary school children varied between five and twelve, and with students in training between two and three; the averages cannot therefore be regarded as reliable. Fuchs and Haggenmüller, in presenting a group of words, kept the same number of repetitions for a given series, and the presentation time consequently varied, being necessarily longer for spelling by letters and transcription. With Itschner the presentation time was constant, and the number of repetitions accordingly varied.

Lay drew general conclusions on the teaching methods of orthography from the results of his experiments on unintelligible material, but memory experiments suggest that such an inference is not valid. Lay's material was so arranged that the sight and the sound of the word corresponded, but the difficulty of orthography in school practice is with words which do not so correspond. He also claimed that motor imagery—vocal and graphic—played a predominant part in orthography. But the time factor, which he ignores, accounts for the superiority of transcription and of spelling the letters aloud over the other methods. It is easy to see in this time factor, and the accompanying analytic work of attention, the real cause for the divergent results of the different methods. In the method of dictating words the time factor and the analysis

of the word suffer. The word strikes the ear of the pupil in a fleeting fashion and he has no opportunity for analysis, whereas in transcription he is compelled to analyse. Even when, in dictating, the word is also repeated by the pupil, an analysis of the word is not secured. In spelling the letters a relatively effective analysis of, and a certain concentration on, the word occur. From this standpoint it is easy to account for the varied results obtained. The methods used do not sufficiently fulfil the conditions of psychological experiment to guarantee adequate analysis of the different factors involved and to render the results unequivocal.

From the point of view of method the investigations of Lobsien are sounder than those of Lay. Lobsien's tests were applied to the pupils of a given year in a boys' and a girls' school at Kiel and numbered roughly a thousand. He suppressed vocalising by requiring the pupils to grip the tongue between the teeth. Intelligible material was included, and his tests thereby approximated to school practice more than Lay's. The difficulty in the selection of material of uniform difficulty Lobsien sought to overcome by collecting, after preparatory tests on the mechanical difficulty of reading written characters, intelligible words of relatively uniform difficulty for reading; from the letters forming these words he also arranged nonsense combinations. The difference in the orthography of intelligible words and the writing of the same characters in unintelligible combinations could thus be determined.

Lobsien's series comprised the following:—

(1) Seeing the words with tongue fixed.
(2) Hearing the words with tongue fixed.
(3) Seeing and hearing the words with tongue fixed.
(4) Seeing, hearing, and vocalising combined.

In estimating his averages Lobsien distinguished between errors of substitution and of omission.

The results of Lobsien differ from those of Lay in one particular, namely, that seeing gives generally the better results in the case of unintelligible material, and hearing with intelligible material. He explains this by reference to the connection between thinking and speaking. Meumann, while agreeing with this explanation, suspects that something which favoured the dictating method must have been overlooked in the test: the children may, he suggests, have been unusually practised in phonetic analysis and thus inferred, with comparative ease, the visual orthographic form from the sound.

A more exact psychological investigation than any of the above is that of Edwina E. Abbott.[1] Only four trained observers took part, and the investigation comprised the following five series:—

(1) Comparison of visual and auditory presentation.
   (*a*) Successive visual presentation of the individual letters of a word at the rate of two letters per second, two seconds intervening between each group of ten words.
   (*b*) Successive auditory presentation of individual letters under the same conditions.

[1] "On the Analysis of Memory Consciousness in Orthography," *Psychological Review*, Mon. Supp., vol. x. No. 1.

Ten groups of ten words for each observer for the visual and for the auditory presentation were used.

(2) The influence of vocalisation of the letters or of the syllables, the whole word being presented simultaneously.

(3) The influence of syllabification and the use of diacritical marks of pronunciation.

(4) Successive exposure of the words of a group compared with simultaneous exposure.

(5) The influence in visual presentation of a few seconds' interval, allowed for an immediate recall of an exposed word before exposure of the next word of a group.

Miss Abbott[1] concludes that, irrespective of the method of presentation and the manner of learning, the *typical* mode of recall for all observers is through the visual imagery of the letters. The visual mode of recall is also a factor in determining the relative value of the visual and auditory methods of presentation. It seems to have been tacitly assumed by some writers, she observes, that the recall might be in terms of auditory imagery whose arousal might be the easier when the perception had been auditory instead of visual. Her results show, first, that visual imagery is at once invariably substituted for the heard letters and, secondly, that the heard letters are never recalled in terms of auditory imagery. This fact alone makes the auditory method of pre-

[1] "On the Analysis of Memory Consciousness in Orthography," *Psychological Review*, Mon. Supp. vol., x. No. 1, pp. 153–55.

sentation poorer than the successive visual presentation of the letters. The other results of this comparison of the two methods of presentation are, however, of more importance. It is found that the combining into syllables of the letters, as they are presented, is of prime significance and that the successive presentation of the letters prevents this. The necessity for giving the letters successively in auditory presentation therefore prejudices this method in comparison with a method which admits of the simultaneous presentation of the letters.

The value of vocalisation seems from this investigation to depend, first, upon whether it is vocalisation of the syllables or of the individual letters; secondly, upon the relative predominance of the visual processes of the individual observer; thirdly, on the part played by the auditory imagery connected with the observer's incipient or actual vocalisation of the syllable—it is this vocal-auditory process in learning with which the visual imagery of the letters becomes associated. Thus the observer's vocalisation of the syllables is always an aid, but the vocalisation of the individual letters may be a hindrance. Other points in the analysis show how the latter may take place. The vocalisation of the letters is, in the first place, a slow process and prevents repetition of the word. In the second place, it may be a hindrance to combining the letters into syllables, especially for the observer who is predominantly visual. This may explain the results of Lay, who found that, when the children were required to vocalise the letters, more errors were made in recall than when, as in transcription,

such vocalisation was not required. It is to be further noted that we have here a process that is an aid in learning, but is not, as a rule, present as an aid in recall.

It is evident, then, from the above account that we are only at the beginning of the experimental treatment of orthography, and can as yet arrive at no definite conclusions as to the best method of presenting the subject.

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CHAPTER XVI

PSYCHOLOGY AND PEDAGOGY OF THE INSTRUMENTAL SUBJECTS

ARITHMETIC

THE importance of the study of arithmetic for practical life is beyond question, and the demands made by society on the school in respect to this subject are great. Any help which Experimental Education can offer to the teacher will therefore be welcomed; but at present only one or two of the problems of the psychology and pedagogy of arithmetic have been subjected to exact investigation. The results of these investigations may nevertheless indicate the lines which future inquiry in this subject may follow with some hope of success.

In no subject has the doctrine of formal discipline and transfer of training been so persistently maintained and retained on *à priori* grounds as in arithmetic. Those who profess to have abandoned the view that mathematics provides a general training of intelligence which is applicable to any other branch of knowledge or in any department of life are nevertheless easily beguiled into declaring that "accuracy" is transferred from one arithmetical

process to another. It is to the credit of Winch[1] that he has sought to determine quantitatively, in a given case, whether this contention is justified.

The procedure adopted was to use parallel groups of pupils,[2] arranged according to tests in problematic arithmetic; one group was trained in rule sums, while the other did work other than arithmetic, and thereafter both were tested by problems involving arithmetical reasoning. In marking the tests in arithmetical reasoning no account was taken of the accuracy of numerical computations, marks being assigned solely for the steps in reasoning involved; while in a later investigation the pupils were required only to write down how they would solve the problems. Winch concludes that although there is a high positive correlation between the two processes, great improvement in accuracy of arithmetical computation seems to produce no improvement whatever in the accuracy of arithmetical reasoning.

A similar investigation is reported by Starch.[3] The training series here consisted of multiplication tests, and the initial and concluding series consisted of problems in adding fractions, and adding, subtracting, multiplying, and dividing numbers of two, three, or four digits. He concludes from his results that training in one type of arithmetical operation

[1] "Accuracy in School Children: Does Improvement in Numerical Accuracy 'Transfer'?" *Journal of Educational Psychology*, vol. i. pp. 557–89, vol. ii. pp. 262–71.

[2] For procedure see Chapter II., above.

[3] Starch, D., "Transfer of Training in Arithmetical Operations," *Journal of Educational Psychology*, vol. ii. pp. 306–10.

improves very considerably the ability to perform other fundamental operations. The explanation given, based on the introspection of the subjects, is that improvement is due to the identical elements acquired in the training series being directly utilised in the other arithmetical operations. The two main factors are the increased ability to apprehend and retain the numbers, and the acquisition of the ability to visualise arithmetical operations.

The contradiction between the conclusions drawn from the results of the two investigations is apparent only. In Winch's experiment there is no transfer, because no relation between the processes tested exists. In Starch's, where the elements of the training series are involved in the testing series, there is transfer. These investigations then confirm the view, generally accepted at present, that the effect of transfer is proportionate to the number of common processes involved.

Tests by Wimms[1] to determine the relation between improvability, retentiveness of practice effects, fatiguability, and output of work, show that these are not the same for any one subject in addition and in multiplication. Myers accordingly states[2] that for subjects of school age there can be no doubt that the two tasks differ materially in character.

Arithmetic then, we may conclude, cannot be

[1] Wimms, J. H., "The Relative Effects of Fatigue and Practice Produced by Different Kinds of Mental W[illegible] *British Journal of Psychology*, vol. ii. pp. 153–95.

[2] "Introduction to Experimental Psychology," p. [illegible]

regarded as one subject, having a special faculty corresponding thereto: it comprises a series of operations, some more or less related, some completely independent one of another. Further investigations will probably enable us to define exactly the relations between the various processes.

We now turn to consider the question of the origin of number in the mind of the child. The idea of number, so far as our knowledge of child psychology at present extends, appears relatively late in the development of the child.[1] The sensory activity of the child, his perception of spatial relations, his linguistic powers, and in part also his technical skill are often highly developed before he arrives at a comprehension of number. The ability to count or repeat numbers, say up to ten, only indicates that a series of closely associated terms has been learnt; it is no guarantee that the significance of the names of the numbers is known. Nor is the fact that a child recognises when one of his playthings has been removed a proof that he knows the number of them. Children entering school at six years of age do not, on the average, comprehend beyond three or four, and the child's knowledge of number compares very unfavourably with his other knowledge. As the child in his daily life, in his play, etc., has every inducement to count, and yet does not avail himself of his opportunities, we must conclude that number cannot depend on mental processes easy to him.

If we seek to determine the mental processes on

[1] *Cf.* Münsterberg, "Psychology and the Teacher," p. 284.

the development of which the comprehension of number depends, we must at the outset reject the comprehension of spatial relations, since the child possesses a very correct knowledge of these long before he acquires the conception of number. The nature of number appears rather to be connected with two processes which develop relatively late in the child's mind: one, the temporal aspect of number, the other its abstract nature, which requires that it should be apprehended in isolation and freed from its embodiment in perceptual objects and processes. It is noteworthy that the child's conception of time is likewise of late development. As already mentioned,[1] a very defective comprehension of the time aspects of experience is possessed by children of six and seven years. The acquirement of ideas of time appears to occur in the same period as the first ideas of number. The factor of rhythmical or arhythmical repetition of the same impression seems to be of great significance in the acquisition of the first ideas of number.

It must be remembered that when a young child sees a number of similar objects lying together, only with the greatest difficulty, if at all, can he apprehend these simultaneously; this is due to his defective ability to concentrate attention and his undeveloped capacity for synthetic combination of objects. The child comes to comprehend a plurality of objects existing in space only successively, through a corresponding number of single perceptual acts, and their manifold existence is for the child's mind at the outset a manifold repetition in time of the same

[1] Chapter V.

impression or of similar impressions.[1] Since, then, the simultaneous presentation of objects in space does not alone induce the idea of number in the mind of the child, it follows that a comprehension of time relations must also be necessary.

On these grounds it is maintained by some that elementary instruction in number should begin with counting. Others hold that the idea of number arises from the simultaneous visual perception of objects, and these would commence instruction with the comparison of groups visually represented, using for this purpose the so-called number-pictures. Historically, this latter view must be attributed mainly to Pestalozzi. All knowledge, according to Pestalozzi, must be based on *Anschauung*, that is, the direct perception or immediate experience of things. *Anschauung* he resolved into three elements —word, form, number—the last of which acquaints us with the quantitative relations of objects of perception. Number is thus an aspect of observation or immediate experience of things and, accordingly, the basis of arithmetical instruction must be purely perceptual. Pestalozzi thus became the precursor of the modern methods of teaching arithmetic through number-pictures.

[1] *Cf.* statement of Professor James: "Number seems to signify primarily the strokes of our attention in discriminating things. These strokes remain in the memory in groups, large or small, and the groups can be compared. . . . We amuse ourselves by the counting of *mere* strokes, to form rhythms, and these we compare and name. Little by little in our minds the number-series is formed" ("Principles of Psychology," vol. ii. p. 653).

The two methods base their instruction, the one on the spatial aspect of experience, the other on the temporal aspect of experience. As there is no doubt amongst psychologists that in the idea of number both factors, spatial and temporal, are involved, it follows that either method alone is incomplete, and that with each method the child is himself left to supply something. Generally with the spatially based systems, or with the methods of number-pictures, the child has to supply the temporal factor and the ordinal arrangement of number which is largely conditioned by this; the pure counting method, on the other hand, demands that the child should be able to represent to himself perceptually a multiplicity of objects in space and to apprehend these simultaneously in one visual act. It is thus evident that only by a method giving due recognition to each factor can the child come to a perfect comprehension of number.

The individual endowment types of the pupils must play a large part in determining the method by which the idea of number is acquired.[1] A pupil of the visual type of imagery will be favoured when, in teaching, the numbers are represented visually, but will be at a disadvantage when the counting method alone is used. As the counting method relies on successive rather than on simultaneous presentation of stimuli, it favours the audile, who is accustomed to work with series of successive associations, whereas the method of using visual representation alone will cause the audile difficulty.

[1] *Cf.* Münsterberg, "Psychology and the Teacher," p. 284.

Although originally the idea of number may be dependent on the successive presentation of like stimuli and accordingly on counting, investigation has shown that, when once the idea of number has been acquired, a direct estimate of a definite plurality of elements is possible without counting. Eight to ten elements presented simultaneously can, under favourable conditions, especially with suitable grouping of the elements, be directly estimated by the eye, and about fifteen by the ear.

Many devices to illustrate numbers visually have been suggested, and investigations have been undertaken to determine which form of element and which arrangement of the elements in a number-picture give the best results. Pestalozzi used lines to represent the elements, but investigation has proved that circles or points are superior.

One of the latest of the investigations into the most easily apprehended arrangement of elements is that of Freeman,[1] and as previous investigators had not applied their tests with both children and adults, but had confined themselves to adult subjects, we shall here consider Freeman's results only. In his tests he used a pendulum tachistoscope with an exposure time of fifty thousandths of a second. Twelve arrangements of points were used in the experiments, and the majority of the series were applied both to adults and to children.

The characteristics which, according to Freeman,

[1] Freeman, Frank N., "Untersuchungen über den Aufmerksamkeitsumfang und die Zahlauffassung," *Pädagogisch-psychologische Arbeiten*, vol. i. pp. 88–168.

facilitate the apprehension of definite numbers of objects are the following: (1) a clear division of the objects into groups; (2) the group to consist of as great a number of elements as will lie within the range of attention; (3) the arrangement of the elements in such a way that an addition or subtraction of an object makes a striking difference in the spatial form of the group and in its relation to other groups; (4) such an arrangement of the groups themselves that a change in the number of groups causes a pronounced difference in the spatial form of the whole figure.

The following were amongst the groupings employed:—

Series I. ● ● ● ● ● ● ● ● ● ●

" II. ● ● ●   ● ● ●   ● ● ●   ●

" III. ● ● ● ● ●
● ● ● ● ●

" IV. (unit = 6) ● ● ●   ● ●
● ● ●   ● ●

" V. (unit = 4) ● ●   ● ●   ●
● ●   ● ●   ●

" VI. (unit = 3, arranged vertically) ● ● ●
● ● ●
● ● ●
●

Series V., with a unit of four and the groups arranged horizontally, gave the best results with

adults. With a unit of six, as in Series IV, the groups appear to be too large.

In his investigation Freeman found that single units arranged in a row up to five are judged with an average of 20 per cent. of mistakes: six objects are in 50 per cent. of the cases judged rightly. A double row is just as easily apprehended as a single row containing only half of the total number. An even number of points is not so often rightly apprehended as an odd number of points. In groupings by twos the evenness or oddness is usually apprehended even when the number itself is not estimated.

Grouped objects are more correctly judged than ungrouped objects, and a horizontal division of groups increases still further the accuracy of apprehension. Of the groupings used in Freeman's tests the rectangular form was proved to be the most suitable with adults. To facilitate the correct apprehension of a large number of objects two methods of procedure may be employed: the one the conscious apprehension of each single group by itself and then the addition or multiplication of the groups, the other the simultaneous apprehension of total groups.

A number of visually presented objects can by means of the visual image be exactly reproduced, for example, by drawing, without the idea of their number being present in consciousness.

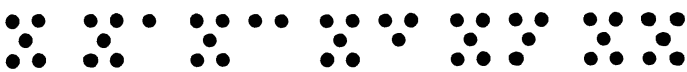
There exist great variations amongst individuals in their accuracy of apprehension, the extremes being 54 per cent. and 94 per cent. The subjects are uniformly distributed between the two extremes,

so that we cannot distinguish two clear types, as has been suggested by previous investigators. Only a few subjects belong to the purely analytic type of apprehension or to the purely synthetic: the great majority belong to the mixed type. Subjects belonging to the mixed type vary the attention or observation process considerably, according to the kind of stimulus presented and the degree of practice. The great majority of subjects in Freeman's investigation—eleven out of fourteen—over-estimated in 50 per cent. of cases. There exist great individual variations in over-estimation and under-estimation. Reflection leads to over-estimation, that is, to a higher statement than that of the actual number of points presented. Between the observation types, analytic and synthetic, and the accuracy of apprehension, or between these and the degree of over-estimation or of under-estimation, there exists only a slight correlation. Between the degree of over-estimation and under-estimation and the accuracy of apprehension there is, however, a considerable correlation.

The mental characteristics which contribute to accuracy of judgment include the range of attention; apprehension of formal characteristics: and such mental processes as sharp discrimination between what is clearly and what is obscurely perceived, the tendency to perseverance of errors, and to supplementing what is given.[1]

[1] Freeman, Frank N., "Untersuchungen über den Aufmerksamkeitsumfang und die Zahlauffassung," *Pädagogisch-psychologische Arbeiten*, vol. i. pp. 143–44.

Applying similar tests to children, Freeman found that children are not so often correct in their estimation of the number of points, and this is the more pronounced the younger the pupils. The simpler forms of grouping are better apprehended than the complex; and complete groups, in comparison with the incomplete, are more correctly estimated by children than by adults. Children apprehend preponderatingly in horizontal rows. Simple vertical series, *e.g.*, $4=\begin{smallmatrix}\bullet\\\bullet\\\bullet\\\bullet\end{smallmatrix}$ are somewhat worse apprehended than similar horizontal series, *e.g.*, $4=\bullet\bullet\bullet\bullet$; but double vertical series, *e.g.*, $7=\begin{smallmatrix}\bullet\bullet\\\bullet\bullet\\\bullet\bullet\\\bullet\end{smallmatrix}$ are quite as well apprehended as double horizontal, *e.g.*, $7=\begin{smallmatrix}\bullet\bullet\bullet\bullet\\\bullet\bullet\bullet\end{smallmatrix}$ Groupings in fives give with children the best results: this arrangement will be understood from the following:—



5 6 7 8 9 10

The range of attention is with children one or two points less than with adults, and with an increasing number of points accuracy decreases more quickly than with adults. Children under-estimate oftener than adults, but for other reasons. The children apprehend the complex on the basis of an inexact general impression. The exact form

of the whole is likewise not so well apprehended as by adults. Falsifying assimilation appears frequently with young children. They introduce into the object a perfectly irrelevant scheme, that is, their apprehension is very strongly coloured subjectively. A correlation between the status of the pupil in the school and his correctness of judgment has not been established.[1]

The accurate timing of the various arithmetical processes is a form of investigation disclosing differences which otherwise would pass unsuspected. Thus the simple subtracting process requires longer than addition; and this is explained by the fact that children lack practice in reversing the order of the figures, and it is suggested that with practice this difference would disappear.[2]

The significance for arithmetical instruction of the mental number-forms mentioned by Galton[3] might also prove a suitable subject for investigation.

The whole field of arithmetic demands investigation on the lines of experiments indicated above. At present we can hardly even say that we are at the beginning of the experimental pedagogy of arithmetic.

[1] Freeman, Frank N., "Untersuchungen über den Aufmerksamkeitsumfang und die Zahlauffassung," *Pädagogisch-psychologische Arbeiten*, vol. i. pp. 167–68.

[2] Münsterberg, H., "Psychology and the Teacher," p. 285.

[3] "Inquiries into Human Faculty," Everyman Edition, pp. 79–105; *cf.* also Stratton, G. M., "Experimental Psychology and Culture," pp. 252–53.

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CONCLUSION

FROM the outline of the subject of Experimental Education given in the foregoing pages, it will be evident that we are at the beginning of a new movement which will doubtless take rank in the history of Education beside the efforts of Comenius to give Education a method. The aspirations of Pestalozzi and others after a scientific method are now coming to be realised; and the instruments are now being fashioned which, when applied, will place the science of Education on a sure basis.

The new methods will make untenable the old opinion that only experience and tact are necessary for successful teaching. The time is past also when to "apply" the principles of adult psychology might be thought a sufficient basis for a science of education. The psychology of the child of school age is a department in itself and, as has been illustrated, its results sometimes differ from those of adult psychology.

In the review of Experimental Education which we are now concluding, new solutions to old problems have been suggest[illegible] problems

have been disclosed. The subject is, however, far from finality. The results given are in many cases not yet beyond criticism; some are even incompatible with others; and the incompleteness of the whole treatment will be apparent to all who reflect on educational questions. But the lines are now laid down on which future work must proceed.

Amongst the problems which stand in need of more immediate investigation, the following may be enumerated. The general development of the child demands further investigation, more especially the arrests or inhibitions in physical development, their causes, and the means whereby they can be overcome. There is also the parallelism between physical and mental development, which in turn necessitates further investigation of the standards of, and means for determining, mental endowment and general intelligence.

In regard to the special intellectual functions, a more exact consideration of the perception and observation of the child, especially on its apperceptive side, is required. The development of the child's thinking and reasoning, and the increasing degree of abstractness of his concepts, should be further studied in relation to the demands made by the various subjects of the curriculum.

In respect to the emotional life and the volitional development of the child, more extensive and exact investigations are required of the religious and ethical feelings, of the content of religious ideas, of ethical judgments, and also of individual and social ethical relationships. These investigations

can only be prosecuted by means of a method of questioning, partly by determining the content of religious ideas through careful cross-examination of a large number of children of various ages, and partly by submitting for their judgment questions on ethical and social relationships, stories, situations, actions, judgments, and proverbs.

The development of the child's æsthetic appreciation likewise demands closer study. Attempts should be made to discover the criteria by which the child's likes and dislikes are at various stages determined. It is important in this connection to distinguish the æsthetic from the non-æsthetic estimates of a work of art; to the latter belong all judgments which depend on the content—for example, judgments from the practical, ethical, or religious standpoints, which ignore the formal elements of artistic representation. It is the development of the deeper æsthetic appreciation which stands most in need of investigation, to enable us to say to what extent teaching in æsthetic appreciation is possible and to determine the value of works of art in education generally.

The synthetic aspect of Experimental Education is, so far, almost untouched. It is important to determine, with regard to endowment, whether the various mental functions can be trained simultaneously, or whether a fundamental antagonism between certain functions exists, whether, for example, the training of observation arrests the child's power of abstract thinking. When this has been attained, Experimental Education will then

be able to treat the child as a unity, instead of, as at present, regarding him from many different standpoints.

Experiment in General Didactic should be directed mainly to the consideration of the technique of learning. The recent tendency in education has been to insist on the importance of the content in instruction: this should now be supplemented by a study of the technique of learning, and the pupil should, where possible, be made cognisant of the best methods of study and the stages in learning, so that he may know when most profitably to seek the assistance of the teacher. If this aspect of the subject be designated "formal training," the term will then acquire a new and valuable significance in Education.

In regard to Special Didactic, investigations in the psychology and pedagogy of the instrumental subjects require to be continued and extended, and methods similar to those adopted in the case of Reading, Writing, etc., should be devised for, and applied to, all the higher subjects of the curriculum.

In conclusion, it is of interest to note that the general importance of Experimental Education has been recognised by the establishment of pedagogical laboratories in such cities as Chicago, Antwerp, St. Petersburg, Budapest, Milan, Paris, Brussels, Geneva, Leipzig, and Vienna. Japan is expected to follow, in the immediate future, the lead of America, Germany, and France.[1] To arouse a wider interest in Experimental Education than at present exists

[1] Lay, W. A., "Experimentelle Pädagogik," pp. 4–5.

in this country, by presenting to English readers the results at present available, has been the object of this work. It is the earnest hope of the writer that students will be encouraged to follow out various lines of inquiry in this subject, and that they will be aided, in time, by the establishment of pedagogical laboratories for the prosecution of original research in Experimental Education in Great Britain.

INDEX